HELIOTHERAPY

A. ROLLIER

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HELIOTHERAPY

WITH SPECIAL CONSIDERATION OF SURGICAL TUBERCULOSIS

BY

A. ROLLIER, M.D.

TRANSLATED BY

G. DE SWIETOCHOWSKI, M.D., M.R.C.S.

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PREFACE TO THE SECOND EDITION

As the reader will realise, this new edition of Heliotherapy is distinctly different in many important respects from the first. Many British colleagues having advised me of the superiority of the plan of the 1924 German edition over the first English edition, I have modified this new edition accordingly. I hope that the British medical public will realise the advantages of these modifications and that the new edition will be at least as warmly welcomed as was the first.

Permit me to express here my very lively recognition of the work of G. de Swietochowski, M.D., M.R.C.S., L.R.C.P., who as surgeon and linguist kindly undertook the translation of the work and the correction of the proofs.

I wish also sincerely to thank the publishers for their share in the production of the book.

A. Rollier.

Leysin,
January, 1927

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PREFACE TO THE FIRST EDITION

The term "surgical tuberculosis" is a misnomer in so far as it involves any suggestion of operative measures as the rational or even legitimate treatment. Tuberculosis, wherever situated, is a general disease presenting local manifestations, and as such demands treatment directed towards the improvement of the general health; such local treatment as is necessary must in no way counteract this indispensable "disinfection" of the body. When, in 1903, I opened at Leysin the first clinic for the systematic application of the sun-treatment, it was my object to place the weakened and diseased bodies of my patients in an environment which would give the greatest possible assistance in the fight against tuberculosis. In this environment, the essential factors are the air of high altitudes and the sun-bath, applied to the whole surface of the body; the bracing effect of this combination is of the greatest therapeutic value. Heliotherapy is a local treatment which is at the same time analgesic, bactericidal, and a powerful stimulus to cicatrization. In choosing the High Alps for the application of this treatment, I was guided by the fact that the climate of these regions is practically the only one in which heliotherapy may be applied with advantage in every month of the year. At an altitude of 5,000 feet the air is never oppressively hot, even in the height of summer; in winter, although the atmosphere is intensely cold, the brilliance of the sun more than counteracts this quality.

Owing to the paucity of our knowledge concerning the action of light on the human body, the development of the technique of heliotherapy was, of necessity, chiefly empirical. I trust, however, that I have imbibed sufficient of the spirit which characterised the work of my much-respected teacher, Prof. Kocher, to have made it none the less scientific on this account. Correctly understood and applied, heliotherapy

fulfils the highest demands of orthopædics and conservative surgery.

The advantages of a non-operative method of this kind are many. Mutilations are avoided, articular function is, to a large extent, maintained; the body recovers its harmonious outlines, and the patient returns to the outer world a *complete individual*, capable of earning his living.

Such treatment should not be reserved for the wealthy, for, apart from all other considerations, it is more economical for the community to pay the cost of one or even of two years' treatment in the sun and open air than to permit the depreciation of human capital necessarily caused by a mutilating operation.

Sunlight is useful, not only in the cure, but also in the prevention of all forms of tuberculosis. At a time such as the present, when all nations are confronted with the problem of raising the national physique to repair the ravages of the Great War, the preventive action of sunlight would amply repay wider study and application.

Heliotherapy is a method of treatment which may with advantage be applied to a large number of non-tuberculous diseases. In *Le Pansement Solaire* (1916) I dealt rather more fully than has been possible in the present volume with the treatment of wounds by sunlight. Such, in brief, are the different applications of heliotherapy which the English-speaking medical public will find developed in the following pages. The present volume differs considerably from the French and German editions of *La Cure de Soleil* which preceded it. In the first place, the section of the book dealing with the scientific basis of heliotherapy has been rewritten and considerably elaborated by Dr. Rosselet, who has been my enthusiastic collaborator since the beginning of my activities at Leysin, at first as a pure scientist and subsequently as both physicist and physician.

The radiographic control of osteo-articular tuberculosis has come to occupy a place of great importance in our system of treatment. I have therefore asked our radiologist, Dr. Schmid, to crystallize in chapter form the impression he has received from the study of his collection of some 13,000 skiagrams.

In order to make this book as complete a survey of its subject as possible, I have not neglected the question of the adjuvants of heliotherapy (of which the most important is radiotherapy) which may with advantage be associated with it in the treatment of such localizations as peritonitis and adenitis. Dr. Amstad, the head of our surgical and radiotherapeutic services, has kindly placed his experience at my disposal, and has written a chapter on adjuvants to treatment, and another on the sun-treatment of non-tuberculous diseases.

As technique is a matter of great importance, I have dealt with this subject somewhat more fully than previously. Although the methods I use cannot be applied in all climates without modification, the general principles of careful progression and strict individualization are the same everywhere. In spite of its apparent simplicity, the practice of heliotherapy demands great attention to detail and constant supervision.

I have also thought it advisable to publish a number of typical or interesting case-histories, illustrated in many cases by skiagrams and photographs; by this means I hope that the study of each localization will be made clearer and more precise, so that the reader who has not sufficient time to read the book may obtain some impressions of the method and its results in a comparatively short space of time.

Permit me finally to tender my sincerest thanks to the two eminent English medical men who have been so kind as to contribute introductory notes to this work. The names of these two distinguished men at the beginning of my book is perhaps the surest guarantee of success.

Sir Henry Gauvain, a Member of the Medical Research Committee on the Biological Action of Light, whose admirable work at Alton permits him to speak with authority in all matters connected with surgical tuberculosis, has first-hand knowledge of the methods in use at Leysin and of the results obtained by them. His opinion as to the value of heliotherapy is therefore of great value.

Dr. Saleeby, well known in the eugenic field, in which he has been a hard fighter in many good medico-social causes, is well qualified to appreciate the social importance of sun-

light. I was pleased to find that, on his recent visit to Leysin, this advocate of helio-hygiene was not disappointed in the results of the therapeutic application of sunlight. I feel sure that the intensive and entirely disinterested campaign he has since carried out in favour of the method I employ has been of great value in attracting public attention to the importance of sunlight for our social well-being.

In conclusion, I wish to express my gratitude to Andrew Morland and to A. Macbeth Morland, who have translated this work after having taken a large part in its preparation. I also wish to thank Macleod Yearsley, F.R.C.S., for his kindness in correcting the proofs, and my publishers, the Oxford Medical Publications, who have made every effort to bring out the book in as satisfactory a form as possible.

A. Rollier.

Leysin,
February, 1923.

FOREWORD

It is ingrained in healthy mortals to love light. Even those of sedentary habits and unfitted for an outdoor existence prefer well-lighted and cheerful surroundings to darkness and gloom. A child before the age of reason instinctively seeks the light and abhors darkness. Light and Laughter synchronize—Darkness and Depression do likewise.

A very sick person may be so enfeebled that he desires darkness, not being sufficiently virile to have power of response to the stimulus of light; he who is convalescing from disease welcomes light, hungers for the genial rays and responds to their influence. Few there are who do not look with regret at the departing swallow and wish to follow it to distant sunlit regions. The wise, whom kindly circumstance permits, take inspiration from that southward flight and also migrate.

Mirth is banished when darkness envelops us, our senses become deadened and dulled and sleep supervenes. Life is at its lowest ebb in the hours of darkness; at that time death most nearly and most often approaches. The darkness of the tomb is synonymous with complete cessation of response, with death.

In all ages there have been Sun-worshippers. It could not be otherwise. Terrestrial life craves for the golden rays. They are the world's great tonic which stimulate and enliven, but in undue excess intoxicate.

Dr. Saleeby has initiated an impressive campaign against the smoke nuisance and the "Diseases of Darkness."

His writings are of great educative significance and have

been valuable in drawing public attention to the urgent need for smoke abatement in our cities and to the therapeutic value of light. This book appears at a fitting moment, confirming his arguments and substantiating his plea.

It is strange, that while we have always instinctively recognised the value of sunshine, so little intensive use has been made of a natural therapeutic agent so potent, so freely and so generally available. It is true that, in keeping with our natural inclinations, physicians have for ages empirically advocated convalescence in sunny localities. Frequently a change at the seaside is prescribed, the benefit of sea-air (so called) being probably to no small extent due to the fact that at the seaside the actinic value of sunlight is so much greater than inland.

In some conditions, and particularly in certain patients, the intensity of the luminous and actinic rays at the seaside is too great. More is demanded from the patient than can be supplied. I have been especially impressed with this fact since I have had the management of two sister Institutions for the tuberculous, the one in the country, the other at the seaside. Certain patients, especially the very weakly or very cachectic, cannot effectively respond to the excessive stimulus at the seaside, and first require very gradual and careful exposure for a long period inland.

The clinician employing heliotherapy soon learns the wide variation in power of response shown by different subjects. Dr. Rollier very rightly emphasises the need for acclimatization and gradual and graduated exposure depending on individual powers of response—individual idiosyncrasies. To the fresh-air-loving Englishman, sunshine must particularly appeal. Part of the value of open-air life may be ascribed to unconscious insolation, which supplements and enhances the benefit derived from cold pure air. We, therefore, especially owe a very great debt to Dr. Rollier. He has taught us to use sunlight wisely but intensively. He is the High-Priest of the modern Sun-worshippers. To those unacquainted with his great work it will come as a revelation; to those familiar with it, it is a great inspiration. His methods are of the highest interest, their value being due to the fact that he

stimulates rather than supplants the efforts of nature to defend the body against disease. Lessons of the greatest importance may be learned by those who will study the principles of treatment he has laid down.

I have had the opportunity of seeing his work, his methods and his results, and I am filled with admiration. At Leysin, amidst beautiful and romantic surroundings, in the pure Alpine air, with abundant sunshine of high actinic value, victims of surgical tuberculosis are restored to health by heliotherapeutic measures applied with skill and assurance that compel attention. For the first time his full technique is available to the English medical public, and I suggest that when his methods have been assimilated and have been applied more generally, the sum of human suffering will be sensibly diminished, the standard of improvement achieved, and the speed in which these results are attained will be sensibly increased. It may be well to emphasise a warning. Sun-treatment is not mere exposure to the sun. The technique requires skill, care and gradual application. Individual idiosyncrasies must be ascertained, but careful study of this book will enable the reader to avoid dangerous pitfalls and disappointments. Largely as the result of Dr. Rollier's initiative, enthusiasm and advocacy, much knowledge has been acquired as to the means by which sunlight exercises its beneficent functions. Much remains unknown or speculative, and it may yet be long before many of the mysteries of successful insolation are unravelled.

To clinicians, however, much as we may deplore lack of precise knowledge as to the manner in which heliotherapy is beneficial when skilfully applied in suitably selected cases, this essential and fundamental fact is abundantly clear, that it is a method of treatment of the very highest value and of the greatest utility.

The clinical results attained in Surgical Tuberculosis when skilled heliotherapy is utilised are much superior to those obtained when insolation is not employed. The improvement is especially striking if progress made amongst patients in a large Institution is compared during periods when heliotherapy is possible or is not. Sun-treatment unquestionably

aids, accelerates and consolidates the cure. It is an adjuvant which, in the light of available knowledge, it would be a crime to neglect.

Recent research has shown that exposure to cold air raises and maintains high, metabolic activity. To what extent aerotherapy or heliotherapy is of relative value need not be here argued, as the employment of the one necessitates utilization of the other.

Heliotherapy in this book is especially concerned with the treatment of surgical tuberculosis. It may be well to point out that its value is not confined to this disease, and a special chapter is devoted to heliotherapy in other conditions. Indications and contra-indications for its employment are discussed, but if we remember that it is a powerful stimulant of the natural defences of a patient, the scope of heliotherapy becomes immeasurably increased. I hold strongly the view that insolation would be of great value in many debilitating diseases, during convalescence following specific fevers, and indeed in almost all cases where the natural resistance of the patient to disease needs to be increased and amplified. Its value in preventive medicine will be increasingly appreciated after experience in its employment has been acquired. Schools in the Sun, Insolation in Insolation Hospitals, transference of Hospitals for chronic disease to sunny localities must naturally follow. The mental alertness and accompanying striking physical improvement which follow heliotherapy suggest that the intensive use of light, and especially of natural light, might be judiciously extended to almost all conditions and spheres of human activity.

Finally, it is a comforting thought that while Leysin is peculiarly, I might almost say pre-eminently, an ideal situation for the practice of heliotherapy, the fact that only the few may avail themselves of Dr. Rollier's skill need be no cause for discouragement. Wherever the sun shines and the requisite skill exists for its utilization, there insolation may be usefully employed. There is abundant sunshine in these islands, especially in the south of England, during a large part of the year. It is up to us to use that sun when it is shining, and the improvements now being made in artificial light apparatus

bid fair to make a reliable and valuable substitute for natural sunshine available at all seasons.

Dr. Rollier has earned our gratitude by laying the sure foundations of a valuable method of treatment destined to have wide and ever-increasing application. I wish this volume and his work all success.

H. J. Gauvain.

Harley Street, W.
January 1923.

FOREWORD

BY

CALEB WILLIAMS SALEEBY

M.D., F.Z.S., F.R.S. (Ed.)

In 1921 I first saw Leysin, directed thereto by Dr. Ceresole of Lausanne, with whom I had discussed my campaign for what I call helio-hygiene, based upon such considerations as the notable acceleration in the decline of tuberculosis in New York, which, during visits and inquiries in that city in the two previous years, I had found to follow the sanitary regulation of 1905 forbidding the production of coal-smoke.[1] Nowhere on earth have I seen, or heard all, of anything so beautiful, so significant, so hopeful, as the application of heliotherapy under the charge of Dr. Rollier. On the following day I first opened his book, *La Cure de Soleil*, published shortly before the war, and submerged in that destructive deluge. Only a few minutes were needed to breed the determination that the book which taught what my eyes had just seen in the flesh—the whole, healed, happy flesh of hundreds—at Leysin, must appear in English, for the needs of all who speak that tongue, on both sides of the Atlantic, and especially for us in the British Isles, whose cities, thanks to our self-imposed curse of coal-smoke, and to our infamous slums, are the darkest on earth. The publication of the pages which follow is the satisfaction—and more, for it is really a new book—of that desire. Meanwhile it has been my privilege to see the work of other helio-therapeutists and to realize, more certainly than ever, the significance of such practice as theirs for the life of man whenever and wherever he builds and inhabits cities—as he must, for what does the very word civilization mean? From these lessons he "must learn or perish."

[1] See *The Eugenic Prospect*, Part II, "Let there be Light." London: Fisher Unwin & Co.; New York: Dodd, Mead & Co. 1921.

The superb results of Sir Henry Gauvain at Alton and Hayling Island showed me that much more extensive, systematic and fundamental inquiry into the scientific foundations of the sun-cure was necessary—for evidently even our English sun, and even at sea-level, can heal. After a few months' reiteration, a demand for the proper organization of such an inquiry was met by the Medical Research Council, which appointed a Committee on Sunlight, with Sir William Bayliss as its Chairman, and Sir Henry Gauvain as one of its members. Vastly more than even the unequalled relief and cure of surgical tuberculosis is involved in this question, but only when the scientific foundations are laid can we build the structure of heliotherapy and, better still, of helio-hygiene, which will afford for us the full gamut of the value of sunlight, and make an end of the diseases of darkness—" les maladies de l'ombre," as Dr. Rollier translates my phrase—from tuberculosis, the prince of the powers of darkness, down to rickets, the widespread curse and ugly scandal of our British malurbanization.

The publication of this volume cannot fail to interest and stimulate the many and energetic men who, from English-speaking North America, are showing a shining example to all the world. Shortly before my first visit to Leysin I had learnt, in Winnipeg, how indignantly the health authorities of that splendid young city were dealing with a very trifling and transient pollution of the air and obstruction of sunlight by coal-smoke. Since that date I have learnt, in Boston, how the " Floating Hospital " (a ship at anchor in its historic harbour) serves to expose ailing children to the sunlight, which is guaranteed to them by the city's " Blue Sky Law," and to cure them by its incomparable means. And as recently as December 1922 I had the advantage of seeing the work of Dr. Alfred F. Hess of New York, and of his colleagues, in Columbia University, and at the Home for Hebrew Infants, where he has shown that the quantity of phosphorus in the blood of babies *rises* from spring to autumn and *falls* from autumn to spring, whilst the incidence of rickets (" la maladie de l'ombre par excellence," as Dr. Rollier has remarked of it to me) consentaneously falls and rises. (It was an Englishman, Dr. Theobald Adrian Palm, who, in 1890, in the *Prac-*

titioner, a generation ago, first taught the relation of rickets to darkness and to sunlight; but no one heeded him.)

The very few who have protested, in England, that we were sinning against the light, are now seen to be right: John Evelyn, who wrote his *Fumifugium* in 1661, and condemned the "hellish cloud of sea-coal that maketh the City of London resemble the suburbs of hell"; and John Ruskin, who inveighed against the "plague clouds" that ascended from our industrial cities and was thought to be a fool for his pains; and Sir Benjamin Ward Richardson, one of the few doctors who have had Latin enough to know that doctor means teacher; and Sir William Blake Richmond, the painter who knew that, as St. Augustine said, "Light is the queen of colours." Dr. Rollier and his followers have vindicated them all; and in praise of the sunlight the half has not yet been said. Who could have guessed, a year or two ago, that a few minutes' exposure to it will double the quantity of phosphorus in a baby's blood in a fortnight; or cure rickets as rapidly and certainly and costlessly as Dr. Harriette Chick and her fellow-workers, sent from London to help and to learn from the hapless children of Vienna, have lately demonstrated?

Our houses, our hospitals—consider the wards of St. George's Hospital at Hyde Park Corner, and contrast them, in the light of the following pages, with Hyde Park itself, unused for cure—our schools, our factories, our clothes, all these and more must be reconsidered as we emerge from the last—for surely it must be the last—of the Dark Ages into the light of day. For evidently the real meaning of Dr. Rollier's work is not clinical but hygienic; I praise it, here and everywhere, in order to end it, leaving him nothing to do but to write his memoirs.

Meanwhile it is a serious question whether, in Britain, so long as we continue to make many of our children tuberculous, we should not send them to Switzerland, where they can be cured by the sun in a year or two, rather than treat them for many years until they die, in any of the various dark places on which we rely at present, and some of which it has been my miserable experience recently to visit in search of more light. That question must be reiterated, at whatever cost of offence to vested and other interests. How grave and for-

midable is the opposition which the champions of the light in Britain must overcome may be illustrated by a personal experience when I was publicly taken to task by the Medical Officer of Health of one of our great industrial cities for my "suggestion that sunshine can cure tuberculosis."

What can be said of the fact that a high authority could write as he did nineteen years after Dr. Rollier began curing tuberculosis by sunlight, not more than twenty-four hours away from our shores? Or what can be said of those who persist in confounding light and heat (as if Shakespeare had written "Fear no more the *light* of the sun"), unable to learn from, for instance, the natural practice of the animals in our Zoological Gardens, who seek the early morning light of the sun but avoid its midday heat? Or of those who persist in confounding light and air, like the critic of my lecture on sunlight at the Congress of the Royal Sanitary Institute last summer, who declined to perceive anything new to learn, for she had herself "been preaching fresh air for thirty-five years"? Or of those who, never having seen heliotherapy in practice, nor having read a line by any of its students, begin by exposing the chests of phthisical patients to the midday sun for an hour or so, and then infer from the subsequent pyrexia, hæmoptysis and autopsy that sunlight is useless in pulmonary tuberculosis? Or of those who proclaim satisfaction with the records of our Sanatorium system in this country, forgetful that of every sanatorium worthy of the name a solarium must be an essential part? Or of the authorities at a large sanatorium for tuberculous children, mercilessly set on our bleak north-eastern coast, which I visited explicitly in order to see the sun-cure; to be told by the teacher in the school which is part of the institution that, when the sun shone, the children were sent into a neighbouring wood, by the doctors' orders, lest the light should hurt their eyes?

No comment seems adequate but Schiller's, "Mit der Dummheit kämpfen Götter selbst vergebens."

I adhere to my oft-reiterated dictum, in reference to Britain (contrasting, for instance, smoky London with smokeless New York, and smoky Sheffield with smokeless Essen), that the

restoration of sunlight to our malurbanized millions, now blackened, bleached and blighted in slums and smoke, is the next great task of hygiene in our country.

To that end may the publication in English of this shining and splendid volume serve, whilst we acclaim its author, and say and sing, after Isaiah and Handel, "The people that walked in darkness have seen a great light; and they that dwell in the valley of the shadow of death, upon them hath the light shined."

London,
Christmas Day, 1922.

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I. HISTORICAL OUTLINE

To write a medico-historical chapter impartially is just as difficult as to compose a political treatise without bias —if not more so; for national sensitiveness and personal *amour propre* are thereby readily wounded.

Contrary to those writers who (without our knowledge) have attempted to lay the paternity of modern heliotherapy at our door, the authors of this book have always been at pains to prove that, in all fairness, the practice of the sun cure is as old as the earth, and that Ben Akiba's famous saying: "There is nothing new under the sun," holds nowhere more good than just here. Also, to speak of the paternity of heliotherapy strikes us as being equally presumptuous as to talk of the fatherhood of the sun himself. Should, however, anyone wish to couple the sun treatment with an inventor's name, then it would appear only just to call it the Method of Herodotus, because it appears from his writings on history (set down in 431 B.C.) that on his journeys he made observations concerning the influence of the sun and sun treatment, and that he had himself considered its indications as well as contra-indications. For he says:

"I saw there something strange to which the people had drawn my attention. Namely, amongst the skeletons that were lying in separate heaps, I found the skulls of the Persians so tender that even with a small stone I could break holes in them; whereas the skulls of the Egyptians were so hard that it was almost impossible to smash them with a large stone. As the cause of this they state —which I readily believe myself —that the Egyptians are in the habit of cutting their hair short from their youth, and that consequently their skulls became hardened in the sun; on the other hand, the Persians have tender skulls because they keep the sun off their heads

from childhood, inasmuch as they wear their tiara hats. Thus, what I saw is explained " (III. 12).

He says further :

" Fishes and small birds, as eaten by them (*i.e.* the Egyptians) are partly salted and partly dried in the sun " (I. 200 and III. 77).

More expressive and precise is a quotation handed down from Oribasius (Greek physician in Rome), which refers to Herodotus :

" Exposure to the sun is especially indispensable to people requiring restoration and increase of musculature ; although one should guard against such rays as have passed through clouds, and one should avoid also in wind-protected parts such rays as may there collect. Furthermore, one should take care that in winter, spring and autumn the sun should have a direct access to the sick person ; in summer, and in the case of feeble individuals, this method is to be avoided ; the head is to be covered during the cure."

One is tempted to believe that it was the Egyptians who gave rise to a comment of Herodotus : " For there, everyone is a physician " (Hom. *Odyss.*, IV. 231, and Herodot., *Hist.* II. 84). Hippocrates, it is related, exposed his patients to the sun ; a passage in his " Aphorisms " (Sect. V., 18, 22) evidently also refers to it : " Frigidum inimicum ossibus, calidum vero utile," and so on.

Antyllus found that the sun arrested the growth of one's waist, strengthened the muscles, increased power and hardened against sickness.

Avicenna, an Arab physician (*circa* A.D. 1000), also taught that people who exposed themselves to the action of sun rays and at the same time moved about in the open air remained immune to sickness.

Celsus describes sun baths as an efficacious remedy against epilepsy and abdominal troubles.

So that if the application of methodical sun baths can be traced back to Herodotus, we would have to reach very much further back—probably right into prehistoric times—in order to find the first beginnings of recognition of the beneficent effects of the sun.

The places of refuge of our oldest ancestors, the cavemen, have all either an eastern or a southern aspect, which might have served some hygienic purpose.

The history of religion has acquainted us with an early cult of the sun in the Old as well as in the New World; and throughout the ages we find the sun worshipped as the creator and supporter of the human race.

The ancient Egyptians, the fathers of civilization, in their religious and funeral songs, worshipped Ra, the god of the sun, as the dispenser of vital force and health. His name was borne by the Kings (Pha-ra-o).

In Babylon, besides the god in heaven, Baal, Mardouk, Meryal and Givil were worshipped as gods of the sun, harvest and creation.

The highest of all gods in Persia was Ormuzd, the lord of heavens, god of light and goodness; next to him was enthroned the sun deity Mithra.

Zeus, the ruler and father of Olympus and of its gods, was at the same time god of the sun among the Cretans; and Apollo, who announced to men the decisions of the immortals, and was worshipped in Delphi and Delos, was also regarded by the Persians as a god of light. The proper sun god, Helios, had temples in Corinth, Argos and on the Taygetos. Further Sol was one of the twelve gods of Latium.

Up to the present day Anatarenon has been respected by the Japanese as a sun god; equally, the Chinese observe solar cults in honour of the healing and creating deity.

In India it is Mithra, who as a god cures diseases, combats death, and as personification of the sun receives homage; but the great benefits come through the brothers Açvius, the drivers of the ascending chariot of the sun. They dispense health and strength to men and women, young and old.

The subsequent development of proper sun baths was accomplished by the Greeks, who named the treatment "Heliosis." They lay down on the terraces of their houses, by the doors of their temples or even on bare sand over which the sun was shining. Excavations near the temple of Æsculapius in Epidaurus have brought to light a long gallery which had a

southern aspect, and which was connected with an adjoining sick ward.

Herefrom we may be allowed to conclude that the sun had even then already played some part in the treatment of patients.

The Roman solarium was a part of every dwelling-house, and the ruins and pictures at Pompeii still show us numerous examples of these terraces arranged on the roofs of houses, on which one could bask in the sunshine, in peace and privacy. The "thermæ" were equally provided with arrangements suitable for insolation. Renault reports that during the latest excavations in Korbous—a mineral spring near Tunis—the following inscription (dating back to 42 B.C.) was found :

"Decimus Lælius, Decimi filius, balbus quæstor pro prætore, assa, destrictarium solariumque faciundum coeraverit." (Renault : "Cahiers d'archéologie tunisienne".)

Rivier aptly comments on this by adding that the Romans treated their tubercular patients (as well as other cases) in those mineral and salt spas. We see thus that 2000 years ago there existed sun and brine baths which differed but little in their use from present-day methods.

Through the rapid conquest of the ancient world by Christianity, with its abnegation of worldly institutions, besides the temples, shrines and pleasure sites, there were sacrificed many therapeutic and hygienic achievements as well. The period of the migration of peoples had thoroughly cleared up what few remnants may have remained; and not until the Renaissance were the building stones again laboriously collected in order to secure foundations for structures that were to come later. But we may look in vain for recognition of the sun as a healing factor at that period; and even as late as the second half of the eighteenth century. No words could be quoted with more aptitude in this connexion than those of Homer : "Why hast thou left the light of the sun, thou poor one?" (*Odyss.*, XI. 93).

Only Rousseau's "Back to Nature" slogan propagated by his school, and the rapid advancement of physics in the field of optics, ushered in the dawn of the newly-discovered powers of the sun.

In 1774 Faure ("Mémoires de l'Academie royale de chirurgie," Paris, 1774, Tome V) published his work on "L'usage de la chaleur actuelle dans le traitement des ulcères." In this he develops his idea of exposing open ulcers of the leg to solar heat at 33° R. In 1776 Le Peyre and Le Comte had the inspiration to augment the action of the sun by the use of lenses, and they reported on healed ulcers and even on cured cases of cancer to the Société royale de médecine (quoted by Monteunis, *Journal de Physiothérapie*, 1907, No. 53).

In 1799 Bertrand laid before the Paris faculty a dissertation the title of which ran as follows: "Essai touchant l'influence de la lumière sur les êtres organisés, sur l'atmosphère et sur différents corps chimiques."

The year 1815 was of outstanding importance for heliotherapy. Loebel (in the *Journal of Practical Treatment*, by Hufeland and Harless, Vol. II., Part VI., 1815) was responsible for the appearance of a paper: "Important Opinions Regarding (the consideration of) Insolation in Various Disorders, (especially in) Case History, and (concerning the) Realization (of the conception) of a Sun Bath." This paper contained a full list of indications and contra-indications. Loebel recommended insolation in all disorders in which the vegetative powers of the organism had suffered; in which the extremities felt cold, where general weakness and sluggishness of the lymphatic system were pronounced. Such were cases of chronic dropsy, gout, rheumatism, intestinal troubles, chronic gastrospasm and chronic diarrhœa, in which the cutaneous functions were upset or suppressed. Also cases where the intestinal tract acted vicariously for the periphery of the body, and also in a number of nervous disturbances. Amongst contra-indications were, according to Loebel, acute inflammatory conditions, lung troubles associated with inflammation, blood spitting, hæmorrhages of all kinds, congestions, and gastric disturbances. Loebel prescribed partial sun baths and also constructed a special box suitable for them, and must therefore be regarded as the originator of the "box light bath," the object of which was to increase the action of sun heat. His "heliothermos" consisted of a box the walls and the roof of which were made of glass, the floor being covered

with sand or kitchen salt, whilst the head of the patient protruded through an opening in the top.

In the same year (1815) appeared an *exposé* of Cauvir's on "Les bienfaits de l'insolation." Herein were mentioned the following indications: general debility of every kind and degree, a low condition of all organic systems, and a certain form of chronic phlegmasia.

The first man to tackle the question scientifically was the chemist Döbereiner ("Introduction to the Demonstration and Application of all Kinds of Stimulating Baths and Curative Waters, such as are taken by the Sick and Healthy." Jena, 1816). In this work we find the principles of photo-therapy laid down for the first time on the basis of experimental investigations.

The merit of having enlarged the range of indications for heliotherapy belongs to the French, and especially to the school of Lyons, who extended this form of treatment to the tubercular forms of arthritis.

Bonnet, surgeon to the Hôtel-Dieu, recommended in his "Traité des maladies des articulations" (Tome II., 3me partie, chap. I, page 224, Paris and Lyons, 1845) insolation in cases of arthritis of the knee joint as the method of choice. Moreover, he not only favoured its local application, but advised that insolation be taken up as a general mode of treatment.

Lebert was of the same opinion, and reminded his readers of the fact that Bonnet had found heliotherapy particularly successful in the treatment of chronic affections of the joints. ("Traité pratique des maladies scrofuleuses et tuberculeuses," Chap. V., page 423. Paris, 1849.)

The way in which Ollier, and especially Poncet, had carried on the traditions of the Lyons school, including the principles of Bonnet, will be shown presently, for two other names must first be mentioned which, at the commencement of the 'fifties, became strong pillars of the new treatment.

Turck, 1852 ("De la vieillesse comme maladie et des moyens de la combattre"), drew attention to the favourable influence of sun and air baths. He gave exact instructions concerning the use and the method of application. He regarded the beneficent result of the sun baths as being due to a triple

action on the skin through the medium of air, light and heat.

In 1855 a Swiss layman, Arnold Rickli, contributed considerably to the growing use of the sun and air cure by founding an institution in Veldes (Austria) and publishing a paper on " The Atmospheric Cure."

As we have just mentioned, the idea of Bonnet's was not allowed to fall into oblivion by the Lyons school. Ollier, and especially Poncet, had in their turn made use of heliotherapy in the treatment of tubercular joint troubles. They exposed to the sun patients who were suffering from variously situated tuberculosis, as well as cases with badly healing wounds, all of whom were placed on the balconies of the old Lyons hospital. The result of this rational treatment prompted Poncet to suggest to one of his students as the subject of a thesis the following : " L'héliothérapie comme traitement des tuberculoses articulaires," E. Millioz. Lyons, 1899. Therein were mentioned four cases from this eminent surgeon's practice, all of which showed marked improvement in the course of heliotherapeutic treatment, carried out partly at Lyons and partly in the South.

Until 1911 I had been quite unaware of the existence of this thesis ; and on its discovery I took particular care to give it its well-deserved publicity. So in Switzerland we have, quite independently from the French, come to apply and to recommend heliotherapy when treating external tuberculosis in all its forms, irrespective of the age of the individuals.

The purely empiric experiences in heliotherapy were followed by publications dealing more closely with the scientific aspect of the problem. Credit is due to Finsen, the famous Dane, not only for having examined the usefulness of local insolation, but also for having studied the special properties of the various rays of the sun's spectrum. He erected for himself an enduring monument in his remarkable works on the treatment of smallpox by means of red light, and on the treatment of lupus by ultra-violet rays (" On the Importance of Chemical Light Rays." Leipzig, 1899).

It is true that previous to Finsen's publication Maine had employed sunlight in lupus ; but he did this only on account of its cauterizing properties.

A short while later sunlight became a subject for scientific laboratory investigation. On all sides important scientific publications appeared which attempted to explain the mode of action of this so valuable therapeutic factor. We must mention here especially the works of Roux, Arloing, Koch, Marcuse, Strebel, Weinzierl, and above all the interesting observations which Herman v. Schrötter brought back with him from his scientific expedition (organised by Professor Pannwitz) to the Peak of Teneriffe.

With the exception of Uffelmann (Rostock) and Winternitz (Vienna), who exposed scrofulous children to sunlight as early as the eighties of the last century, and of Finsen, Mag, Lenkei and Busek—all the other investigators were occupied with the penetration of light in the body and with its effect on micro-organisms. V. Schrötter studied the scientific side of the whole question very thoroughly, and in a praiseworthy manner collected the respective material in its entirety for the Congress of Tuberculosis in Rome in 1912.

In 1903 I decided to open a clinic in Leysin, amidst the Alps of the Canton Vaud, at a height of 1300 metres. This was the first clinic devoted exclusively to the systematic treatment of external tuberculosis by heliotherapy; at the same time it was placed at a high level above the sea. At present we have over 1200 beds divided among thirty-four different clinics placed at an altitude of 1250, 1350 and 1500 metres respectively, and reserved exclusively for cases of surgical tuberculosis.

During my four years as an assistant at Professor Kocher's private clinic I had the opportunity to get thoroughly acquainted with this form of tuberculosis; because at Berne, as elsewhere, these cases constitute the majority of hospital inmates. In spite of the brilliant temporary results of our eminent teacher, so frequently achieved thanks to his marvellous technique and his most scrupulous asepsis, it appeared to me that the operative treatment of external tuberculosis was far too imperfect to be considered as the fundamentally correct method, or a method of choice. For it is a fact that an operation does not alter the constitution of the patient, and that it cannot prevent relapses or delayed manifestations of tuberculosis.

It struck me that tuberculosis was one of those infective diseases in which the character of the substrate—that is, the individual power of resistance—played a remarkably decisive part, so that our efforts must of necessity be directed towards strengthening the substrate and thus bringing about a quicker cure of the local focus by treating the whole organism. And, after all, there are only general remedies available in the case of internal tuberculosis. It was surprising to see, on the one hand, how pulmonary tuberculosis was without the slightest doubt favourably influenced by general treatment in the mountains (thus explaining the quick development of sanatoria), whilst, on the other hand, nothing of this kind was being done for the surely no less interesting cases of bone and joint tuberculosis. Whilst in all countries numerous sanatoria were built in order to secure for the victims of the first category a strict hygienic régime in conjunction with open-air treatment, for the members of the second group, with the exception of a few seaside houses provided exclusively for children, no steps whatever had so far been taken.

It was in order to meet this urgent need that the first Leysin institution was established. An uninterrupted cure, one that was practicable all the year round, was here meant to bring about a transformation of the whole organism besides the complete repair of tubercular bone and joint foci. Over and above this, however, I did not for one moment lose sight of the requirements of rational orthopædics.

For I felt that only by this combination of means could the chances of recovery be enhanced. Incidentally the experience gained during my practice among an Alpine population had proved the advantages of open air and sunlight in the course of treatment at high altitudes; so that these two factors had been jointly utilized right from the beginning.

A year before (1902) Bernhard—then surgeon to the Samaden (Upper Engadine) Hospital—had commenced the practice of insolating torpid wounds (of which fact, however, nothing was then known to me); and it was for this reason that Samaden was quite properly called the cradle of heliotherapy. Bernhard noticed that the inhabitants of this part of the world dried their meat in the sun; he concluded therefrom that a similar

desiccation might also be employed in the treatment of living tissues. He was also prompted in this direction by the remarkable successes of Finsen achieved by employing chemical rays of solar spectrum in the treatment of bacterial dermatoses. He thus combined the hydrophile properties of dry and pure air at a given altitude with the bactericidal and sclerosing effects of sun-rays, most intensive at such high levels. Bernhard started his observations by exposing wounds, especially those that were healing badly; later he also subjected to the same treatment cases of external tuberculosis. In the year 1904 he reported on the remarkable results of his methods to the Swiss Medical Association at their annual meeting. He also described fully the results of the ten years of his experience ("Heliotherapy at High Altitudes, with Special Consideration of the Treatment of Surgical Tuberculosis," Stuttgart, 1912).

At the above-mentioned meeting I was also able to communicate my results in connexion with sun cure as applied to surgical tuberculosis.

Just as in Switzerland the practice of heliotherapy was revived upon the sunny plateaux of the Alps, so the shore of the Mediterranean was to become its new home in France. But it will be observed that by the sea this cure is limited only to the winter months, and, in fact, it has never been carried out systematically. Vidal and Jaubert in Hyères, Revilliet in Cannes, Grinda, Chiais, Monteunis and Malgat in Nice were its exponents. Malgat was the first to practise sun treatment in pulmonary tuberculosis, while Monteunis may rightly claim to have for the first time combined this treatment with air baths in nervous disorders.

Further successful attempts were made by Armaingaut in Bordeaux and Reboul in Nîmes.

Gradually people began to evince a growing interest in this method, even in the lowlands. Von Escherich, the eminent but unfortunately early deceased Vienna pædiatrist, had studied our cases and the arrangements that were made for them very thoroughly, and wrote subsequently of "the surprising, striking, and irresistibly convincing results of heliotherapy" (*Wiener Med. Wochenschr.*, 1909, No. 29). He afterwards materialized his impressions by constructing a solarium on the roof of his

Vienna clinic. Equally was Jerusalem inspired by his visit to Leysin when making his first heliotherapeutic attempts at Grimmenstein. He reported on his good results in the *Zeitsch. f. diät. u. physikal. Therapie*, 1911, Vol. 4, Part 7, On "Sunlight Treatment of Surgical Tuberculosis," *Wiener Klin. Wochenschr.*, 24 Jahrg., page 539, 1680, and in the *Proceedings of the International Congress of Tuberculosis*, Rome, April 1912.

About the same time Bardenheuer (Cologne), a veteran champion of the operative method, had crossed over to the camp of the "conservatives." He, who once upon a time was one of the boldest interventionists, after his visit to Leysin completely altered his views in order to become an enthusiastic supporter of heliotherapy. In addition, not content with mere lip service as a mode of expressing his enthusiasm, he introduced the new method into the sphere of his own activities, namely into the Municipal Hospital at Cologne; at least as far as this was practicable under local and climatic conditions. Later on he also published his results on "The Heliotropic Treatment of Peripheral Tuberculosis and particularly of Bone and Joint Cases," *Deutsche Zeitsch. f. Chirurgie*, 1911, and "The Sun Cure of Peripheral Tuberculosis," *Strahlentherapie*, 1912.

Similarly Wittek, of Graz, having paid a visit to Leysin, returned to his native land a warm supporter and defender of heliotherapy, and introduced this method in the pædiatric station at Aflenz (Styria), of which he happened to be superintendent. ("Sun Treatment of Surgical Tuberculosis," *Beiträge zur klin. Chirurgie*, Vienna, 1912, Vol. 30.)

De Quervain, of Bâle, encouraged me long ago to make further steps in the direction I had already taken. He published his impressions of the sun cure and his own results therefrom in an introductory chapter to the theses of my two assistants, Drs. Franzoni and Witmer, in Vol. 114 of the *Deutsche Zeitsch. f. Chirurgie*, as well as in the *Semaine médicale*, Sept. 11, 1912, and finally in his report to the Surgical Congress in Berlin, 1913.

The favourable results of heliotherapy prompted me to go a step further and to render the sun cure serviceable also for purposes of prophylaxis. Already in 1910 my own house,

not far from Leysin, had been exclusively converted to this end. The outbreak of the World War, with all its upheavals and hindrances, brought the development of heliotherapy to a temporary standstill; though, of course, the sun cure was hereby only confronted with new demands, namely those of war surgery. But at the present moment the whole question has once more come to the front, owing to the increasing prevalence of tuberculous infection. On all sides the sun is now being reckoned as a factor equally important from the social as well as from the therapeutic point of view. The efforts made in this direction and their reflexions in literature specially dealing with this subject are already so numerous that a complete review would lead us too far.

II. EXPERIMENTAL CONTRIBUTIONS

What rays are they which, through their special properties, bring about a cure of our patients? In what way do they accomplish this? And what physiological processes attend this course of recovery? These are the three great problems to the solution of which a large number of recent works seek to contribute their share and, if these questions have not yet been solved, this may be explained by their great complexity; for numerous and widely different branches of science have to contribute to the working out of these problems.

An attempt will now be made to explain the sequence of these manifold elements, whilst at the same time offering the reader as accurate a review of contemporary opinions as possible.

Since the remarkable successes of insolation in cases of surgical tuberculosis at high altitudes have largely been ascribed to the influence of ultra-violet rays, I undertook in 1908, jointly with my collaborator, Dr. Rosselet, exact investigations, consisting of comparative measurements of the intensity of ultra-violet rays in the lowlands and at certain altitudes, namely, in Lausanne (450 m.) and in Leysin (1450 m.).

Our method was based on the research methods of Hertz, which appear to be most suitable for this kind of work on account of simplicity of procedure and facility of transportation of the necessary apparatus.

The apparatus employed by us was an open brass cylinder, through the iris diaphragm of which sun rays were allowed to fall upon an amalgamated zinc plate situated inside the cylinder and placed in its geometrical axis. The metal rod on which the zinc plate was resting was insulated against the cylinder by means of amber, and was connected with an electroscope of Delster and Geitel outside the cylinder.

Charged with negative electricity, the amalgamated zinc plate has the tendency to discharge itself under the influence

of ultra-violet rays of sunlight (Hertz-Hallrachs), and the time occupied by the fall of a certain potential (in our experiments this was constantly 630 volts) is taken as a sign of greater or smaller intensity of these rays. We pursued these investigations from April 1908 to February 1909, and they led us to the following frequently-mentioned results.

The difference in the intensity of ultra-violet radiation between mountain and valley is greatest in winter, and becomes proportionately smaller as we approach the warmer season.

Two more conclusions can be deduced from our measurements:

1. The power of ultra-violet radiation is always less in the valley than at an altitude.

2. The decline of its intensity from summer to winter is less in the mountains than in the lowlands.

The first deduction demonstrates the importance of a mountain cure; the second deduction leads us to appreciate the fact that the cure should be extended over the winter months in cases where the gravity of the condition requires it. In winter a patient treated at a low sea level is compelled to interrupt his sun cure, because then the ultra-violet rays, having been largely absorbed by the atmosphere, do not possess sufficient intensity. In contrast herewith winter in the mountains permits of a continuous cure.

Dorno confirmed these variations in the intensity of ultra-violet rays in the course of his year at Davos spent in remarkable and very exhaustive experiments.

Our own investigations relate so far only to the absorption of ultra-violet rays, and do not permit of a comparison with the absorption of other rays. But the work accomplished by Elster, Geibel and Dorno showed that the latter also suffer a considerable loss through absorption. In this connexion it might be interesting to note that, at least as far as is known to me, no measurements exclusively concerned with infra-red rays have yet been carried out. Calculations in respect of the solar heat radiation have, as a rule, applied to the whole spectrum (for instance, Ångström's pyrrheliometer; the experiments of Violle on Mont Blanc and at the seaside).

It is known, however, that the infra-red waves can pass easily only through gases that are perfectly dry and free from

contamination (dust, bacteria). We may, therefore, accept it as a matter of fact that, in their passage through the atmosphere, they must undergo a marked absorption : one that is perhaps even more considerable than the absorption of luminous rays.

Having thus recognized the importance of the influence exercised by ultra-violet rays in heliotherapy as demonstrated by physical measurements, we must now investigate their peculiar properties and also the biological conditions under which they become effective or otherwise betray their influence.

We know already that pigmentation is caused by these ultra-violet rays, and that this pigmentation is again indicative of a predisposition to recovery. This relationship between the appearance of the pigment and the presence of ultra-violet rays in white light has been proved by many experiments. I myself confirmed this in 1908 in the following manner. A fluorescent plate of yellow (uranium) glass was placed on the abdomen of one of the patients. Whilst all round the glass typical pigmentation took place, there was complete absence thereof underneath the glass. What was one to conclude therefrom ? Surely nothing else but that the rays from red to yellow—that is, rays of greater wave-lengths (as compared with the ultra-violet ones)—were not able to induce any pigmentation. When, later on, in a similar experiment, a plate was used that transmitted only the blue and violet rays in the spectroscope, I found that this inability to form pigment had spread to the violet part of the spectrum. It was thus that I arrived at the same conclusion as Finsen and other writers—namely, that it is mainly the ultra-violet rays which cause skin pigmentation.

These results have nothing unusual about them when we think of the intensive absorption of ultra-violet rays, which, when directed against the body become absorbed, already in the superficial layers of the epidermis. Their energy becomes transformed into chemical energy, which plays its part in tissue cells and in the blood, and as a result we see the formation of pigment. This shallow penetration of living matter by rays of short wave-length has been fully demonstrated by exact investigations. Finsen himself became aware

of it whilst attempting to destroy tubercle bacilli within the lupus papules.

The power of penetration can be augmented by creating anæmia of the skin, which phenomenon may be studied in the following manner.

Having compressed a human ear lobule between two quartz plates, we find by the use of the spectroscope that all colours composing the white light are present. When, however, the pressure is released and the circulation thus restored, we see that the red and the yellow rays remain visible, whilst the violet and ultra-violet rays have disappeared, having been absorbed partly by the skin, but particularly by the blood.

Somewhat later Jansen succeeded in showing that in a skin that is well supplied with blood these rays exercise their bactericidal effect down to a depth of 1·5 mm., and that under their influence the virulence of the bacteria is lessened to a depth of another 4 mm. The more recent and very accurate work of R. A. Hasselbach has confirmed the powerful absorption of ultra-violet rays.

How does pigmentation take place under the influence of these rays? This problem is one of the most difficult in biology, in respect to which no unanimity has so far been reached. Since it is well-nigh impossible to imagine a living being without its pigment, we are forced to regard the latter as something especially important for vital activity. In fact, the question of pigment formation represents one of the basic problems of general biology.

Two theories have been advanced of late to explain the origin of pigment. One assumes pigment to be autochthonous; the other assigns it to the instrumentality of the blood. Both of them have been championed by renowned scientists. In support of the second theory we have the blood investigations of Schmidt (1889), who was able to follow the transformation of hæmoglobin into black pigment in frogs. Carnot confirmed this through his observations on the intestine of leeches. Unna, Quincke and Finsen adhere to this theory on the strength of the so often mentioned and so frequently repeated observation (Eternod and Robert) that in the neighbourhood of the main vessels there are to be found chromatophore substances.

And now, what speaks in favour of the autochthonous origin of the pigment? Jarisch noted that melanin could originate from red blood-corpuscles, and various histologists (Post, Andrux, Retteren) laid stress on the following: 1. In the mammalians they found pigmented epidermis without any pigment being present in the cutis and vice versa. 2. Hairs planted into a pigment-free bulbus showed the presence of pigment.

Finally we must mention the experiments of Bataillon, who experimented with frog larvæ and reports that he saw the pigment arise from chromatin, and not from hæmoglobin. Meirowsky published some very telling observations of his own. He noticed in the nuclear substance the presence of a " pyrenoidine nucleus," so called on account of its property of easily staining red with pyrenoidine. According to chemical views this nucleus ought to be built up from tyrosine, that amino-acid which is regarded as the final product of the protein molecule. Meirowsky managed to follow up this " pyrenoidine nucleus " with the aid of a stain, from the centre of the nucleus to the nuclear membrane, where it became less stainable owing to chemical transformations. He watched this nucleus reach the cell protoplasm, where, under the influence of diastase, it was turned into pigment granules quite devoid of any staining capacity. All stages from the red pyrenoidine to the brown pigment are alleged to have been seen by this author.

For my own part, however, I should not be inclined to draw any sharp line between the two above-mentioned theories, because I believe that each of them contains a part of the truth. In 1888 Neumann made a report which deserves mention here. He was studying hæmorrhages from normal tissues, and he noticed repeatedly that blood which had entered tissues became transformed into pigment only where it came into contact with living cells. This observation might serve us as a bridge between the two theories of pigment formation in so far as that, perhaps, the red blood corpuscles which cease living under normal conditions and are undergoing dissociation give rise to pigment on coming into contact with normal tissue cells. I believe that the skin pigment is produced in an analogous way under the influence of ultra-violet rays,

because under this very influence the absorption spectrum of the blood shows absorption of the short wave rays. But the absorbed rays react chemically on the substance by which they became absorbed.

We take it, therefore, that the blood corpuscle which has absorbed the short wave rays becomes itself dissociated through their agency. Vaso-dilatation, such as might be brought about by the long wave rays, would facilitate the contact between the short wave rays and the blood, so that protoplasm or cell chromatin could then, through the medium of diastase, turn the remnants of hæmatin into pigment. Maas expressed the same idea in 1889 by stating that hæmoglobin in a fluid state penetrated the cellular body and became transformed there into pigment through the molecular activity of the cell. I am inclined, however, to go further still. I consider the dilatation of vessels in itself insufficient, and I believe that a simultaneous destruction of hæmoglobin must also take place, because, although pigmentation appears speedily in a skin that has been exposed to heat rays, such pigmentation disappears soon after the exposure; on the other hand, irradiation with luminous light, containing a rich admixture of ultra-violet rays, results in a lasting pigmentation. This difference can be explained through the fact that, in the first instance, no hæmolysis can occur, on account of the absence of ultra-violet rays. Dubois demands the presence of two components for every pigmentation: (1) a chromogenous body, and (2) a zymase or an oxidase. Gessart arrived at the same conclusion on the evidence of his own experiments. Horaud placed the origin of chromogen in the skin cells, whilst he made the blood corpuscles responsible for the formation of zymase.

In accord with Dubois, Bloch and his pupils have recently thrown an interesting light on the origin of pigment. The oxidising ferments of the epithelial cells are believed to prepare the pigment intracellularly out of such substances as Bloch's dioxyphenylalanine (dopa), which are chemically related to adrenalin. The direct experiments of Bloch carry a great power of conviction, and are worthy of closer attention, the more so as they can be brought into harmony with the general biological effect of light. And, indeed, it is practicable, accord-

ing to Bloch, to increase the intensity of ferment action enormously through the use of chemically active rays. The demonstrable effect, which varies widely according to the individual, follows in its rise and fall the biological principle of Arndt–Schulze, namely, slight radiation stimuli favour the production of dopa-oxidase (Lutz); medium ones restrict it; whilst strong ones destroy it.

Spontaneous pigmentation proceeds parallel with the demonstrable oxidase content. According to the dopa theory of pigment formation, blood is to be regarded merely as a vehicle for the forerunners of pigment. Such a point of view might possibly explain to us pigmentation through thermal and mechanical stimuli, which, being attended with vaso-dilatation, give rise to a copious supply of pigmentary substances in the skin without the necessity of ferment activation. Hence the evanescence and irregularity of this type of pigmentation. According to Bloch, Addison's spots should have a similar pathogenesis, whereby the precursors of the now deficient adrenalin change into pigment, the ferment content of the epithelium remaining normal.

Bloch's view of the dopa theory squares with the observations collected in the course of my practice of heliotherapy. For some time I have regarded the diastase secreted by the cell itself as the pigment-forming factor, which Physalix was able to isolate from the skin of guinea-pigs. The chemical forerunners of the pigment appeared to me to be liberated during hæmolysis under the influence of light. The question whether Bloch's derivatives of benzol capable of pigment production have any connexion with hæmoglobin remains, however, undecided. Yet it should be remembered that we have in hæmatoporphyrin a substance which for certain originates from hæmatin, and which is capable of sensitising the skin to light in a very powerful way. The substance, of which normally but a faint trace appears in the urine (Garrod), causes, in cases of porphyrinuria, inflammation and necrosis of skin wherever the latter has been exposed to light (hydroa æstivale) which disappear in the dark. Meyer-Betz was successful in demonstrating this on himself by means of intravenous injections of hæmatoporphyrin. The same experiment was also carried out on white mice, which

perished even in diffuse light. Similar conditions can be called forth indirectly by sulphonal and triethyl of lead (Goetze). We have also to remember the presence of iron in the blood (Pincussen), since it is known that even a tiny addition of a metal raises considerably the sensibility of organic compounds to light (Neuberg). We are thus compelled to ascribe to hæmoglobin a prominent part in photo-biological processes.

I have no wish to deny the curative property of long wave sun rays; such an opinion, by the way, had been imputed to me by mistake. Heliotherapy knows of no purely chemical or purely thermal rays. Thermally active rays increase the frequency of molecular vibrations; those that are chemically active influence the building up of the molecule (Shanz). Berthelot visualizes the latter process as a kind of resonance between the light waves and the atomic vibration of the molecule, both of which are alleged to have the same frequency. Hereby some such chemical reactions are set going which otherwise take place only at higher temperatures. Light "lowers the potential" of the reaction. Biologically speaking, it is only the relation between these two qualities of rays that is of importance; the chemical component of the total radiation energy appears to me as being especially important; all the more so, as the scope of short wave rays can be considerably enlarged by the "optic sensitizers" (Tappeiner) that are constantly present in the body. V. Hess has proved quite recently that the facetted eye of animals is in the position of perceiving ultra-violet rays directly and strongly, thanks to the marked fluorescence of its substance.

The view taken by Kisch, according to whom the sun effects were to be regarded as exclusively due to the heat-producing hyperæmia, seems to me to be much too superficial to be sound.

The whole modern practice of phototherapy in rickets, so much in vogue at present, speaks in favour of the importance of short wave rays. Moreover, there are exact data of analytical measurements available. Thus it was shown by Lasch that the quartz-lamp can increase the CaO retention in rickets up to four times the normal; this effect, which sets in in a few days, lasts for months ($1\frac{1}{2}$) after. Hess arrived at similar results. *In vitro* Berthelot and Gaudechon, from a mixture of carbon

dioxide and ammonia, have obtained formamide, which, as is generally known, represents the simplest component part of the protein molecule. The same procedure was applied by the research workers just mentioned to water and carbon dioxide and yielded formaldehyde, which through condensation and polymerization forms vegetable sugar. According to Bierry and Henri, chemical rays lead also to decomposition. Thus saccharose is hydrolysed *in vitro*. Protein, fat and carbohydrates are split in the body cells (Neuberg), creating substances of higher acidity, whereby the peroxidase of the blood becomes increased. Generally speaking, under the influence of light soluble proteins are converted into less soluble ones. "The light creates changes in all organic matters," says Schanz, "whereby short wave rays are able to split those substances all the way down to the elements and radicals." Pincussen recorded collectively these manifold and widespread chemical light effects. How energetic they can be was demonstrated by Gassul, who, by the action of the quartz-lamp on mice previously deprived of their hair, was able to produce extravasation and cellular infiltration of the spleen, liver and kidneys, bordering on necrosis, whilst the skin remained intact. No such action could be shown to be caused by the red light of the neon-lamp. The deep effect of ultra-violet rays, which can be estimated from the disappearance of the oxidase reaction, proves to be unexpectedly marked; for according to Keller it reaches a depth of 0·65 cm. The experimental measurements of Sonne are confirmatory: he states that about 0·5 cm. below the skin the visible rays were able to create a temperature of 47·5°, but the invisible heat rays only 41·7°. The bearable skin temperature reaches 43·8° in the case of invisible light, with 3·11 calories of entry and 2 calories of absorption per 1 sq. cm. of skin; in the case of invisible heat rays, however, 45·5°, whereby 1 sq. cm. of skin can stand only 1·79° calories entry and 1·25 calories deep absorption.

The body is superficially warmed by the invisible heat rays, whilst the short wave luminous rays develop a powerful deep action, such as could only be based on secondary bio-chemical transformation on account of the well-known superficial absorption of these rays. All these rays, to which

life has adapted itself so wonderfully, amount to 30% of the sun's total radiating energy; whereas the artificial sources of radiation discharge but 15 to 20% thereof. It may be said, therefore, that Alpine sunlight scores once more in this connexion, because the atmosphere absorbs roughly 60% of the total amount of the solar radiation, whereby short wave rays are kept back most of all.

It is through the recent study of avitaminosis that we have gained a deeper insight into the bio-chemical action of the sun. In order to be able to utilise sunlight, the body must possess certain vitamins, although both these factors can, to a certain extent, take each other's place. Otherwise light can have a deleterious effect. Eckstein demonstrated that rats fed on a vitamin-free diet and exposed to quartz light suffered arrest of development and met with a quicker death than unexposed specimens. Cases of pellagra and animals fattened with buckwheat suffer, in spring time, from grave skin disorders.

Wimberger showed that light stimulates growth, a fact which he proved radiologically in normal and rickety children. The chart of normal growth exhibits the highest point in July, and the lowest in February. Malling Hausch confirmed this phenomenon by measurements. In rickety children, however, this is still more pronounced, which underlines the importance of the particular season. Nails (Berthold) and hair (Finsen) also grow faster in summer than in winter. Hess again discovered, after numerous estimations of the average phosphate content of the blood of 270 children, that this content, which is 3·92 mg.% in December, drops to 3·58 in March, in order to rise rapidly to 4·35 mg.% in July. Correspondingly, one quarter of all the cases of rickets occur in the second half of the year, and three quarters in the first. Degkwitz (Centenary of German Natural Scientists and Physicians, Sept. 1922, Leipzig) found a distinct shortage of salts in dogs when kept in the dark, caused by metabolic changes in the otherwise healthy animals. In spite of the low phosphate content of the blood in children, such as would otherwise be accompanied by rickets, this disease can be prevented through insolation (Gutman and Franz). The inorganic phosphates of the blood in rickety subjects reach their normal point under the influence of sunlight (Hess and

Gutman). That it is the chemical rays that are mostly involved here follows from the measurements of Lasch, as well as from the light infiltration experiments of Hess.

These findings have recently been confirmed by the analytical researches of Lesné de Sennes and Guillaumin. Neither rickety aplasia of bone marrow cells nor the formation of fatty marrow takes place in avitaminotic animals as soon as these have been exposed to ultra-violet light (B. Ishido). The short wave rays call forth profuse cell proliferation also in the bone marrow of normal animals (Bickel and Tasawa).

The penetrating action of the rays on the whole organism can be displayed only through the medium of ferments, whereby the vitamins act jointly as a necessary co-factor; moreover, they do so in the same manner as does the sun. Pincussen showed that the formation of ferments, otherwise their discharge into the blood, can be artificially augmented by irradiation. It is also probable that the purin bases are split in this way into oxalic acid and carbon dioxide on a larger scale. Best found an increase of creatin in the urine. Pfeiffer was able to create artificial ferments in rabbits such as would split glycyl-tryptophane. Pincussen observed that *in vitro* blood sugar undergoes a change which is compatible with the well-known fact that light can in some diabetics reduce glycosuria to the point of disappearance.

The skin plays an active rôle herein; and, after all, it is recognised to be an organ essential to life, endowed with immunising (Besredka) as well as internal secretory (esophylaxis, E. Hoffmans) properties. The view taken by Kisch, who credits skin pigment merely with a heat-regulating function—whereby more heat is to be lost than acquired—is too narrow and does not touch upon what is by far the most important biological aspect of the insolated, pigmented, skin.

Now that we have studied the formation of pigment, let us consider its function more closely.

The origin of pigment through the action of ultra-violet rays, and especially through their specific " abiotic " component, is (when their intensity is too great) followed by a partial destruction within the organism, such as is identical with the frequently observed erythema. According to the simple deduction

of cause and result, we are obliged to recognize a protective function of the pigment; because once pigment has appeared, no erythema can develop, and the short wave rays can no longer destroy the skin. It was Finsen's opinion that helped to emphasize this protective influence of pigmentation; but the idea that it is this pigmentation that makes the sun cure effective is new. Bohn (on the development of the pigment) says: "Each living being defends and protects itself by destruction."

In an earlier work, carried out jointly with Dr. Rosselet in 1908, I propounded the idea (taken up since by various other authors) that pigment represents a transformer which changes short wave rays into rays of greater wave-length. The latter were regarded as less capable of absorption by the surface of the skin. The various principles which were then laid down should now be brought again into prominence, especially as they are often forgotten or else spoken of as if they were still debatable subjects.

Dr. Rosselet and I were able to prove that the action of ultra-violet rays is a superficial one, and that they become, as it were, exhausted in the upper skin layers when pigmentation takes place. Finsen attempted to arrest the long rays at a certain depth so as to carry as many ultra-violet rays as possible into the deeper layers. His results (in lupus) remained limited to the surface. Since, however, I find that patients with deep-seated tuberculosis are cured when they have become pigmented, I must logically conclude that it is just this pigmentation that renders deep penetration of the long rays possible. Thus I make of the dark discoloration of the skin through pigmentation a similar use to that made by Hertzel with lampblack, with which he covered the surface of a transformer. Similarly Jena, a physiologist, by covering with soot the unequal points of contact of a thermo-electric battery, was able to read off the intensity of ultra-violet rays with the aid of a galvanometer. And this surely was only possible through a change of ultra-violet into heat rays.

György and Gottlieb have, it is alleged, proved both clinically and radiologically that an augmentation of the effect of phototherapy in rickets is possible through oral administration

of eosin. Finally Dreyer was seen to apply sun rays with success at Copenhagen, where these rays are rather poor in active elements, having sensitized them with cosin, erythrosine and similar fluorescent substances. It was precisely these facts that made me conclude that in regions where sun rays are highly active it is the pigment that plays the part of a transformer, as if it were one of Dreyer's substances. Moreover, this transformation takes place in such a manner that short rays are being converted into long ones. This view has been recently confirmed by Meirowsky, but so far as I know it was for the first time expressed in 1908 by myself.

Besides the short-wave ultra-violet rays, which apparently lose themselves in the skin, where a part of them become converted into rays of greater wave-length, there are also deeper penetrating rays whose bactericidal power is considerable. This was proved by the investigations of Wiessner, who found that the long-wave red rays, and particularly the infra-red ones, have strong bactericidal properties. Experiments of Finsen, Ominus, Sarason, Darbois, Busck and Lenkei point to the fact that besides the red and yellow-red rays, those of shorter wave-length also are able to penetrate living tissues (ear, cheek, head). Busck obtained a good diapositive through a hand 2·8 cm. thick.

The highest power of penetration is possessed by the red and infra-red rays, as was shown also by Lenkei. The experiments of Schmidt showed that luminous rays as well as heat rays can even pierce thicker layers. It can be seen from a diagram that when the skin is exposed to solar radiation to the extent of 138·5 sq. cm., the amount of light that passes through the tissues of the skin and possesses a wave-length of 50 $\mu\mu$ (that is, green) corresponds to 12 sq. cm. The amount of light that can pass through the skull, in the neighbourhood of a wave-length of 750 $\mu\mu$ corresponds to 1·4 sq. cm. The penetrability of fatty tissues and muscles was tested in special experiments. In the case of fatty tissue, a layer 1 cm. thick was used, and after a second there was already a distinct reaction on the plate, whilst in the case of muscle substance of a similar thickness a reaction was seen only after a lapse of 60 seconds. Kime, Hortadler, and Malgat have

reported, on experimental grounds, that rays which affect photographic plates are also capable of passing through the thorax. My own trials include radiation of plates through thorax, forearm and hand. My assistant physician, Dr. Witmer, obtained clear light effects through muscle layers of 7 to 8 cm. on perortho-plates.

Subsequent tests carried out by other helpers of mine resulted in finding that sunlight passes through the cheek and the auricular cartilage within 5 minutes to such an extent that even ordinary Kodak films become affected very distinctly.

According to researches instituted by various authors, such as Nagel, Schmidt, Klingmüller, Halberstädter, and especially Finsen and Jansen, the death of the bacteria is not to be solely attributed to the action of light, for a conspicuous part is played by the inflammatory reaction of tissues set up through insolation. The leucocytes seem to be positively chemotactically influenced by the light. The heat rays of the spectrum bring about a powerful vaso-dilatation also of their own accord, thus favouring transmigration of leucocytes on a large scale. We can prove this reactive inflammation on the surface of the skin. Its characteristic symptom is a well-marked hyperæmia, accompanied by swelling and serous infiltration, and even by a separation of the upper layers of the epidermis.

The bactericidal properties of the blood circulating in an insolated body are being subjected to fresh and exhaustive inquiries, which, although not quite ripe yet for criticism, are nevertheless able to throw an interesting light on this question. Thus Potthoff and Heuer showed that the experimental formation of typhoid agglutinin in rabbits under the influence of ultra-violet radiation exceeds the normal titrates of pigmented animals, but does not equal those of albinos. The sharp rise of the titrate is followed, on continued insolation, by a marked fall, a phenomenon which, according to Stäubli, is attributable to the intensified metabolism of the irradiated animal. Bacilli exposed to ultra-violet radiation become more sensitive to plasma action, frequently degenerate, and appear to become an easier prey to phagocytosis (Azzi). It is alleged by Königsfeld that through the instrumentality of the ultra-violet radiation a favourable influence is exerted upon the action of

præcipitins, agglutinins and hæmolysins, also an increased resistance of irradiated rats against inoculation with carcinoma can be obtained. Similar clinical observations have been made by myself.

The action of mountain climate can never, strictly speaking, be separated from the action of insolation. That it is so can best be seen when studying the influence of both these factors on the composition of the blood. Stäubli has written various works on the intimate therapeutic co-operation of air and sun at high altitudes, and his results are briefly as follows.

1. The growing increase in the number of red blood corpuscles *pari passu* with a rise above the sea level is an established fact.

2. Hæmoglobin, as well as the total amount of blood, show an increase.

3. No neutrophil leucocytosis sets in at a high altitude in the mountains.

4. There is rather a tendency to a lowering of the leucocyte indices, to an absolute diminution of the neutrophils and to an increase of the mononuclear forms.

5. High altitudes have thus a different effect on erythropoiesis as compared with leukopoiesis.

The physiological rise of the erythrocytes is constantly found in our cases of surgical tuberculosis. It sets in during the first days and reaches $5\frac{1}{2}$ to 6 millions at a height of 1500 m. Concurrently with the growing numbers of the red blood corpuscles a slight increase of hæmoglobin takes place also.

According to Hobert's latest experiments, the regeneration of blood in artificially bled animals is hastened by daylight, whereby first the hæmoglobin content and then the erythrocyte count are restored.

Now as to the leucocytes, we find—in contrast with Stäubli, who examined healthy individuals—that in our surgically tuberculous cases there is a definite increase of the total reading. In slight cases of closed tubercle, leucocytosis remains below 10,000. Open tubercle shows, according to the investigations of my assistant physician, Dr. Bardenheuer, almost constantly the figure of 13,000 on admission. In respect of the various kinds of leucocytes, he found in all open and suppurating, as well as in a few closed cases (peritonitis and adenopathies), an

increase of the polynuclear elements at the expense of the lymphocytes (70% polynuclear against 10 to 20% lymphocytes). This ratio of percentages is particularly striking in children, in whom the contrary would be nearer the normal.

Towards the end of the cure a reversion of the white blood count takes place. The count of the polynuclears falls and that of the lymphocytes rises.

It is very difficult to make comparisons with corresponding conditions prevailing in the lowlands, for the reason that blood examinations are not often made in surgical tuberculosis. Cabot noted amongst twenty-six cases of tuberculous peritonitis mostly normal values, and in seven cases even subnormal ones.

The peritonitis cases sent to us at Leysin belong mostly to the bad forms. Is this perhaps the reason why we find such high leucocytosis in our cases, or is it due to the reaction of the sick organism, brought about by the mountain climate?

Still less precise appears to be our knowledge when we are asked about the effect of solar radiation on the blood count.

That a certain influence must take place in this respect during general insolation seems *a priori* likely. For we have only to remember the action of hydro- and thermo-therapeutic procedures and the blood changes associated with them. The investigations in respect of similar actions of the sun bath, both in the valley as well as at an altitude, have not yet sufficiently advanced for us to be able to draw reliable conclusions.

Will the person who is subjected merely to a local sun treatment show a smaller degree of leucocytosis at the insolated spot as a result of active hyperæmia? This also is not at all improbable, on the analogy of passive hyperæmia, for already Nötzel has observed the great numbers of leucocytes under the elastic band as applied experimentally in animals.

Similarly, we do not know yet how much of the effect of light on such vital functions as respiration and circulation is due to the heat and how much to the luminous rays of all kinds.

Insolation acts vaso-dilatorily on the circulatory system, and by means of an extensive hyperæmia of the integument accomplishes a decongestion of the inner organs. Again certain reflexes excited by light might determine the course of the

respiratory mechanism. Furthermore, specific photochemical reactions must be taking place as a result of skin insolation such as would create metabolic products, which, in their turn, would influence distant organs and their chemical activities.

Rothman confirmed the fact that irradiation causes arterial hypotony and hypoglycæmia (Pincussen : increased sugar tolerance), and he took it to be a sympathetic hypotony coupled with a suprarenal insufficiency. Also, quantitative alterations of the tyrosine content of the blood are found in conjunction with pigment deposits in the skin. Irritation of cutaneous nerves and chemical absorption in the skin appear to be the determining factors in these transformations of the blood.

V. Schrötter has pointed out the possibility of these metabolic products originating in the skin under the influence of sunlight (such as amino-acids, tyrosine or tryptophane derivatives), and producing the above-mentioned effects.

The same writer has further explained the positive growth of energy exhibited by the body through the absorption of light by hæmoglobin, this being an increase of oxidative processes in agreement with the views of Vierordt, Quincke and v. Behring. Diesing calls this process the " light charge " of the blood, which must stimulate the exchange of gases between the blood serum and the tissue cells. According to Schläpfer, blood circulating in the periphery of the body undergoes, through the medium of short wave rays, such changes as enable it to give up in the deeper parts of the organism that energy which it had taken up. This view found another supporter in Jesionek. Hasselbach again would like to make the conversion of oxyhæmoglobin into methæmoglobin responsible for the increase of energy. V. Schrötter has expressed his belief that short wave rays can also affect the amount of oxyhæmoglobin dissociation. The effect of light would facilitate the passage of oxygen from the blood to the cells in need of it.

Now, as far as the influence of ultra-violet light on respiration is concerned, the following observation was made by Hasselbach and confirmed by Rubow and Mahler : " If a naked body is exposed to a powerful ultra-violet light, the frequency of matutinal respiration becomes considerably reduced hereafter, whilst its depth increases in almost the same proportion."

Further insight was gained into the connexion between insolation and respiration through experiments carried out by K. A. Hasselbach and I. Lindhard at Brandenburg House, in the Oetztal Alps (3290 m.). Under the stimulus of sunlight these workers observed a rise of the respiratory volume, which again fell with the passing of the effect of the ultra-violet radiation.

In relation to sunlight and cardiac action, Malgat and I found a reduction in blood pressure, indicating a depletion of the inner organs. According to Hasselbach and Bach, this is the result of a direct action of the ultra-violet rays, probably via the nervous system. This is evident from the rapidity with which this effect follows even a short exposure. The fall of blood pressure would thus be due to a dilatation of the peripheral vessels by a direct influence of the radiation on the vasomotors, and not due to a centrally conducted process. In contra-distinction to this, however, the calming, alleviating influence of short wave light speaks rather for than against a central effect of the radiation on the respiratory centre.

A further characteristic effect of the ultra-violet radiation is the quickening of the fermentative metabolic processes, and especially of disintegration, as evidenced by a rise in oxygen consumption and an increase of nitrogen excretion.

The influence of the sun's rays on the kidneys may in this way be explained through their influence on circulation. It is possible that this is also aided by some products of cell metamorphosis arising from irradiation and acting on the renal epithelium. Diuresis depends on the extent of the simultaneous perspiration, which again must undergo a rise in proportion to the increased absorptive power of the skin towards radiated heat and be dependent on the degree of pigmentation.

Finally we see the mental state brighten up and the output of work augment under the influence of the sun. The beneficent action of sunlight in this connexion has been experienced not only by medical men, but by others as well, who may observe it not only in themselves, but also in their environment.

In the clinical part space will be allotted to a more detailed consideration of the strikingly sedative and pain-allaying action of the sun bath.

III. CLIMATOLOGY

Under what climatic conditions is heliotherapeutic treatment best carried out, and where are these conditions to be found fulfilled? To answer this question it will be expedient first to discuss the various climates, however briefly.

Flat Country

This exhibits mainly the following climatic peculiarities :

1. It is open to all kinds of winds, since it is devoid of surrounding and protecting elevations. The number of calm days is very much reduced.

2. The differences of temperature between the seasons are extreme : hot summers; raw, cold winters.

3. From the hygrometric point of view, the atmosphere of the lowlands is distinguished by a high water-vapour content, rising to saturation.

4. As a result of this high moisture content of the air, we see an almost continuous formation of steam, which varies from a light transparent blue veil of mist to a thick, impenetrable fog.

5. *Pari passu* therewith goes a reduced power of light and a reduced intensity of the chemical rays. It might be added here that this intensity is always less in the lowlands than in the mountains, and that this difference increases from summer to winter, reaching its maximum during the cold season.

6. The atmosphere of the flat country is by no means bacteriologically pure. The numerous highways that traverse such parts of the world, and the dust created thereon, also the dampness of the air and the consequent diminution of the bactericidal effect of light are all factors encouraging the growth of the germs, helping them to spread and assisting in their maintenance.

Of course, many of the just quoted drawbacks are lessened in an undulating country rich in forests. The air is there above suspicion, and, on the other hand, a greater protection is offered against the winds. But there are still the raw cold winters to be faced, and the atmospheric moisture, favouring an extensive formation of mists, has to be reckoned with.

Sea Climate

Few climates can be defined so clearly as the maritime climate. For we can hardly find another natural influence anywhere that could even approximately be compared with that arising from the neighbourhood of a great expanse of salt water. The high degree of purity of sea air, which has been so satisfactorily proved by bacteriological examinations, is explained by the complete absence of dust as well as by the frequent occurrence of winds, which pick up the germs and carry them away into space. Another most important factor in this connexion is represented by sunlight, whose beneficent effect is still more enhanced by the presence of that monster reflector in the shape of the water mirror.

Sea air has a high salt-content, which even at a distance of 20 m. inland amounts to 0·002—0·005 g. per 1 cub. m. of air. Equally do we find in it all the other mineral elements of sea water, especially iodine, which is present in twelve times as high a quantity here as in the inland atmosphere; also ozone, bromine and silicic acid.

But besides the above, also the physical influence of the sea on the coastal climate is of the greatest importance. The sea, being an enormous water reservoir, shows a complete contrast to the mainland, which acquires heat very rapidly and loses it rapidly. Therefore, the differences of temperature between day and night and the oscillations during the day are insignificant, and the changes during the year milder.

Barometric pressure shows few oscillations at the sea coast.

Sea air is relatively very damp, owing as much to the frequent rainfalls as to the large amount of invisible water vapour.

We should mention here the great frequency of winds, which range from a light, refreshing sea breeze to the powerful, air-cleansing land wind.

The irregular combination of the above therapeutic factors, some of which may at times be altogether discounted, forces medical men to differentiate very minutely between various portions of the coast. Thus it is that the climatic conditions of the English Channel differ materially from those of the Bay of Biscay, whilst the coast of the Mediterranean possesses characteristic features in a still higher degree. The latter consist of :

1. An exceptionally mild climate (average temperature in winter +10° C.).
2. A great intensity of light, facilitated by relative dryness and remarkable purity of air.
3. Continuity of solar radiation.
4. A small number of rainy days, distributed over a few periods in spring and autumn.

As to the German coasts, we notice that the Baltic, as compared with the North Sea, shows smaller amounts of condensation and longer hours of sunshine, coupled with less marked severity of winds.

Alpine Climate

Should one wish to consider climatology from a purely medical point of view (as is done by Dorno), then one must consistently judge the temperature, moisture, radiation and wind conditions of a climate from the standpoint of the constant body temperature of 98·4° (F.). The climatic factors must be tested in their totality with regard to their effect on the warm-blooded organism. Then, we ought to speak of a " physiological " deficit of temperature and moisture as between man and atmosphere. If this be done, we shall see that the " cooling index " of a body of 37° (C.) in the Alps firstly depends very little on the temperature of the air, and secondly remains extraordinarily constant throughout the year as well as during the twenty-four hours. In Potsdam the cooling indices are twice as high as in Davos. In the Alps the cooling effect of the cold in winter is to such an extent compensated by the atmospheric calm and the equable radiation of the sun, as well as the dryness of the air, that sun-cure patients are able to

maintain their body temperature at the physiological level without any difficulty whatever. In respect of heat production, we must say that, owing to their "physiological" uniformity, the sheltered mountains tax the human organism less than Northern Italy does, although the latter is situated south of the Alps, and even less than the Riviera.

To complete the description of the Alpine climate we ought to add :

1. Small atmospheric pressure.

2. Infrequent winds. Wind-protected places are easily found everywhere in the mountains, and especially on the slopes facing south, which are a guarantee against the cold north winds.

3. Marked dryness of the air.

4. Slight mists and of short duration. These become less and less frequent at altitudes ranging between 1200 and 1500 metres. The inhabitants of such parts often enjoy months of the most glorious sunshine in winter, whilst at their feet stretches a sea of mist, which surrounds the lower situated regions with cold and darkness.

5. Long periods of rain, such as are familiar to the inhabitants of valleys, are quite exceptional in high mountains.

6. The duration of sunshine is much longer at a high altitude as compared with the flat country, on account of the relative scarcity of mists. Particularly striking becomes the difference when we consider the winter conditions. During the four months from November to February the hours of sunshine are exactly double at St. Moritz (1856 m.) what they are in Zürich (411 m.).

Dorno is right in saying that whilst one-quarter to one third of the rays become lost on the heights of the Alps, more than half of them get lost in the valleys. With a low sun and a damp air, only 14% of them gain access to a city like Washington. Of this waste one half is caused through the permanent atmospheric gases and the other half through water vapour.

7. The intensity of light is remarkably great in the Alps. In winter this is increased by the reflecting properties of ice and snow in no small degree. Herewith is connected the uncommon bactericidal capacity of sun rays in the Alps.

(From the many publications dealing with this subject we would like to single out that of Angelika Treskinskajas, which appeared at Davos Village under the direction of Dr. V. Muralt.) Comparative studies made in Davos (1560 m.), Wald-Zürich (903 m.) and in Leningrad, showed that in Davos three hours, in the wood four, and by the sea five hours were required in order to kill tubercle bacilli by means of sun rays.

8. Similarly the intensity of the heat rays is very considerable in the Alps. A rise of the thermometer up to 50° (C.) in the sun is, even in winter, nothing out of the ordinary, while in the shade little more than freezing point is registered at the same moment.

9. The purity of Alpine air is exquisite, as is well known to everybody.

10. Conspicuous radio-activity of the atmospheric air. Saake found that this is enhanced in high mountains. His measurements demonstrated that the air in Arosa (1800 m.) contained on an average three times as much radio-active emanation as Elster and Geitel had found in Wolfenbüttel (75 m.) by the same methods; in fact, the maximum content may occasionally become five times greater than in the lowlands.

These are in the main the characteristic features of the three climates as considered from the heliotherapeutic point of view.

The ideal climate for the practice of sun cure would be one that would allow of a certain daily number of sunshine hours every year and which, thanks to the other climatic factors, would permit of an extensive and almost uninterrupted use of pure, fresh air. But there is hardly such an ideal climate to be found anywhere, that would dispense sunshine day after day. Besides, this is not even necessary. On the other hand, we must insist that the place where heliotherapeutic measures are to be undertaken is protected against wind; that the summer heat is tolerable; and that the cold in winter is sufficiently tempered to enable the patients to enjoy a prolonged stay in the open. Also care must be taken that no fog should rob them of the curative rays of the sun.

Now let us consider which of the above-mentioned climates answers those requirements best.

The flat country is not suitable, on the following grounds :

1. Difficulty of finding spots protected from winds and rarity of calm days.

2. Great humidity of air, by reason of which both the cold in winter and the heat in summer become unbearable. There is a risk of catching colds in winter and in summer the danger of heat stroke from long exposures. Quick evaporation of sweat is rendered impossible on account of the damp warm atmosphere, so that a sun bath in the flat country during the summer months acts, if anything, rather depressingly. It would appear quite impossible to practise sun treatment from October to April in the face of long periods of mist and damp cold, noticeable even on bright, sunny winter days.

3. Considerable weakening of the chemical light rays caused by their passage through atmospheric layers. It is in this respect that the flat country is left far behind the sea coast and the high mountains. But when one takes into consideration the more pronounced cloudiness of the sky prevalent in the lowlands, one finds (Dorno) that " the sea level does not receive by direct radiation even one half of that radiant energy which reaches points placed 1800 m. higher."

4. Absence of dry germ-free air. Presence of dust, smoke and organic refuse, all render the exposure of wounds to the open air impossible without the risk of infection. Besides, such a method would be quite useless, since the complete humidity of air precludes the drying of wounds.

5. Absence of such healing factors as are specific to the sea and Alpine climates.

Should one then regard the application of sun cure at low levels as a mere waste of time? No, far from that. The excellent results obtained by numerous men with insolation in the flat country should suffice to prove the contrary. There are many hospitals where, during the finer months, sun cure is practised with most encouraging results.

However, in all these institutions sunlight cure is only applied in conjunction with other methods at the disposal of the surgeon, therapeutic as well as dietetic, all of which are adopted with the single aim in view of utilising every possible adjuvant of modern medicine in the interest of the patients.

Whether, on account of the relatively unfavourable climatic conditions prevailing in the low regions, it would be worth while erecting institutions specially arranged for the exclusive practice of a systematic and unaided sun cure, is an open question. Some men are earnestly intent to remedy the lack of sunny days and the shortage of ultra-violet rays by introducing quartz-lamps and other artificial sources of light. How far the substitution of artificial light for sunlight can be successful in the treatment of surgical tuberculosis will only be shown in the future, for at present no final judgment is possible.

In any case one must not forget that for the splendid results obtained we are indebted not to the sun only; because the tonic action of the pure and germ-free air plays also no mean part.

The choice becomes very difficult in those cases where we have to decide between the seaside and the mountains, since both of them fulfil several of the above-mentioned conditions indispensable for the application of the sun cure, namely, purity of air and great luminosity of light. As we have said before, a strict division ought to be drawn between the north, west and south coasts of Europe. As regards the coasts of the Baltic, the North Sea, the English Channel and the Atlantic, they all suffer from the disadvantage of low temperatures during the winter months, so that no sun cure would be possible there without considerable risks of colds on the part of the patients. In these regions heliotherapy could be carried out only with an interruption of several months' duration.

More favourable appear to be the conditions on the Mediterranean coast. Temperature is here very constant and always mild. The thermometer seldom falls below + 8° C. and cold nights are unknown. It might appear at first sight as if all conditions for a successful and uninterrupted sun and air cure were here fulfilled. Yet this mild and unchangeable temperature is rather a drawback; for the absence of lower readings in the shade as well as in the night entails the lack of that well-known stimulating and refreshing effect on the whole body, a fact to be regretted. The difference between the sea coast and Alpine altitudes, which is quite noticeable in winter, becomes more so in summer. During the warm season the tonic and invigorating effect of the sun bath is often partially

or even completely abolished on the Mediterranean coasts owing to the high temperature, which does not vary perceptibly in the shade or after sunset. This constitutes the greatest objection to a sun cure on the Mediterranean.

We have thus arrived at the conclusion that the sun cure cannot be adopted anywhere but in the Alps in a perfectly successful and unbroken fashion. We have done so on the strength of purely objective investigations, free from any personal or national considerations.

For the meteorological confirmation of the advantages of the Alps, we are indebted to Professor Dorno, who, through his untiring work in this direction, has given us in his publications very exhaustive data concerning the Alpine climate.

IV. DOSAGE, TECHNIQUE AND CLINICAL RESULTS

1. DOSAGE

If the results achieved by heliotherapy are as good as they are, it is because the application of the sun cure has been built up on a conscientious dosage, which again has been elaborated through an experience of many years. No other method requires such a meticulous and strict individualization and exact adaptation to different cases as the sun cure does. A strict adherence to these rules is indispensable, since the success or failure of the cure depends on it.

In what way will the patient react to the influence of the sun rays? How is one to proceed with the dosage of sun baths? Is a rapid advance, or a slow progress, or even a temporary break in the cure the right thing? These are the leading questions which the medical attendant must put to himself first.

Speaking generally, sun baths are to be administered in such doses that the reactions which they set up have no deleterious effect on the organism. These reactions, of which more will be said later on, are manifold, and they depend on a variety of factors, such as localization, depth and extent of the lesions, their nature (*i.e.* with or without subsequent mixed infection), power of resistance and individual predisposition of the patient, condition of the inner organs (heart, lungs, kidneys, etc.), and last, but not least, on the then prevailing atmospheric conditions.

It is clear enough that the conditions as required for a case with closed tubercle, one that has been enjoying splendid general health and has not been running any temperature, are totally different from those that are needful in individuals troubled with open foci, mixed infection, or, above all, concomitant pulmonary tuberculosis, and suffering from a low general state combined with high fever.

A careful general examination of the patient before submitting him to sun treatment is absolutely indispensable. The state of his lungs and of his heart ought to be watched with care. Equally, his temperature, respiration, pulse, blood pressure, blood (hæmoglobin and blood count) and his urine should be subjected to a searching examination.

During this period of observation the patient must stop in bed. For in this way only can one prevent the reactions of fatigue, which may set in even in perfectly sound sportsmen, who happen to arrive in the high Alps from the valleys without a previous acclimatization, which reactions are still more capable of marring the whole picture in a sick person.

Since the Alpine climate itself plays an important part in the course of the disease, we regard the adaptation of patients to this climate as an imperative condition for a rational sun cure.

Apart from the physiological effects caused by the Alpine air in delicate people at the commencement of their sojourn in the mountains, there is to be noticed a certain degree of excitation, recognizable by a quickening of the pulse rate, feeling of lassitude, insomnia, loss of appetite and even rise of temperature. These symptoms are the more marked, the weaker and the more sensitive the constitution of the patient is. If, however, patients keep absolutely quiet during the first few days after their arrival in the mountains, such symptoms abate, as a rule, very quickly.

As soon as the patients have become more or less accustomed to the high altitude—which process may occupy anything from a few days to a whole week—they commence their cure with the open-air treatment. But care has still to be exercised, and especially in the case of feverish, weak or cachectic patients, who may react abnormally strongly to the influence of pure air.

During the first few days rest in bed indoors is imperative, and only gradually is the patient allowed to get accustomed to the open air through a judicious use of fan-lights, windows and doors. After a time his bedroom windows remain open also at night. In fine weather this is followed by his being placed on the balcony or the solarium, where he spends a

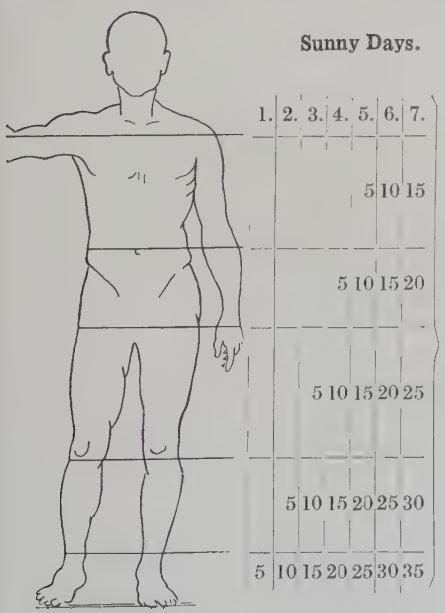
quarter, one-half, or even a whole hour. Within a short space of time he is able to spend there a whole day without feeling the slightest discomfort. During this second stage of acclimatization it is important to continue the control over his temperature, pulse, respiration, as well as the various subjective symptoms, since this control serves as a guide to further progress of the cure.

With this so exactly and progressively adjusted adaptation —which, needless to say, can be altered to suit each individual case—accidents are not likely to happen. After the lapse of one to two weeks, acclimatization has in most cases advanced sufficiently to enable us to begin with the sun cure proper.

Adaptation to Sun Cure

The fundamental principles obtaining here are again: strict individualization and careful graduation.

In order to facilitate the practice of sun baths, we reproduce here a plan of treatment which was first suggested by me and adopted by many heliotherapeutists.



Diagrammatic Course of Sun Cure.

According to the individual reaction, the daily dose may be doubled or tripled.

The dorsal surface of the body is treated in a similar manner wherever permitted by localization.

The insolation continues progressively beyond the seventh day, so that a maximum duration of two to four hours is reached.

After the third week one may proceed to a full sun bath. Neck and head lesions may be exposed to the sun only after a previous preparatory irradiation of the rest of the body.

Let it be clearly understood, however, that in doing this it is only desired to give a rough and general outline of the technique, which has to be varied according to the seat of the trouble, the power of resistance and the local as well as general reactions of the patient.

In every case these irradiations are repeated three times, at intervals of ten minutes each. Thus the insolation of the feet takes 3×5 minutes on the first day, 3×10 minutes on the second, and so on. On the second day the legs are exposed together with the feet, but only for five minutes at a time. On the third day the thighs are included for five minutes, whilst the legs are exposed ten minutes and the feet fifteen minutes every time. On the fifth day, for instance, the patient receives three sittings of twenty-five minutes each, with intervals of ten minutes, whereby first his feet, then successively his legs, thighs, abdomen, and finally his chest are exposed, the latter for five minutes only. The nearer one approaches the trunk the more care is required, especially where pulmonary tubercle is either manifest or suspected.

In sensitive cardiac cases, whether organic or only functional, such as simple tachycardia, the region of the heart is to be covered with a white cloth, while the head and neck are to be covered by a white linen hat with a wide brim. Over and above this, it is recommended to use black or dark yellow glasses.

When the cure is taking a normal course, the three daily exposures may be prolonged. As soon as pigmentation of the skin has become complete—which may take longer or shorter—mishaps are no longer to be feared.

Patients can now, without detriment to their health, be exposed to the sun for several hours. On an average I recommend three to four hours in winter and two to three hours in summer. Only in exceptional cases do I allow longer sun baths—for instance, in cases of young people whose organisms are capable of easy adaptation and who react to treatment by quick and strong pigmentation.

On each occasion the irradiation is applied directly, *i.e.* without any kind of filtration.

The particular initiation of the sun cure, consisting of a

regular introductory irradiation of the lower extremities, is of great importance, for it prevents any possible occurrence of unpleasant surprises, and moreover can be applied to all cases sent in for treatment.

After all, such a procedure is extremely rational. For the harmless insolation of the feet and legs, *i.e.* of a "neutral part of the body," permits us to fix the degree of tolerance on the part of the patient, which is of paramount value during the cure. The innocuous congestion of the feet has a depleting influence on the abdominal and thoracic viscera, which is of considerable moment in diseases of the inner organs as well as in cases where there is a simultaneous lung trouble.

The reactions can be both general and local.

General Reactions under the Influence of Sunlight

We must lay down as a principle that violent and lasting reactions must be avoided (abnormal rise of temperature, tachycardia, dyspnœa, migraine, insomnia, loss of appetite, depression, etc.). The psychic make-up of the patient must not be forgotten. Some patients display such an exaggerated enthusiasm for the sun cure, that they would expose themselves to the action of sunlight until an erythema or a congestion set in if they were not supervised. They should, of course, be kept back; whilst again others, who submit to treatment with a certain nervousness and who exaggerate its effect, have to be encouraged to hold out. A certain amount of psycho-therapeutic handling is here of value.

The cutaneous reactions possess their own significance. Even although the occurrence of erythema can be mostly avoided, further precautions are necessary in people with very sensitive skins. The Venetian blonds, as a rule, react very strongly to sunlight, so much so that from the first the parts to be exposed are covered with gauze in order to prevent burns. That class of patient develops readily a form of "sunstroke," which leads frequently to a slight though unpleasant and painful complication, namely, vesicular dermatitis. This easily discourages them, discredits the cure, and, owing to interruptions, prolongs it considerably.

Age also plays its part in determining the dosage. In general the above method of application is borne well by subjects of any age, on account of the fact that it transfers them into natural surroundings, namely, open air and sunshine.

A little child requires light just as a plant or a young animal does; it basks in the sun with comfort and joy. The old people seek the sun in order to warm their stiffened limbs and to raise their falling vitality. For both the sun cure is valuable, but we must act in these extreme cases with a double amount of caution, since they are particularly sensitive towards " solar reactions."

It may be taken as a general rule, that a sun bath should produce in everybody the sensation of comfort, followed by the sensation of increased strength. Patients should not complain of fatigue, vertigo or abnormal excitation, or in fact of any symptoms mentioned above, which are all due to a faulty method of insolation.

Local or Focal Reaction

As we have seen above, irradiation by means of solar rays can be regarded as an excellent form of treatment in surgical tuberculosis, thanks to its action on the general health as well as on the actual seat of the disease.

As the properly graduated sun bath is the best kind of tonic, through the influence of the sun and of the air on the whole surface of the body, so also has heliotherapy an influence on local lesions, owing to the resorptive, analgesic, bactericidal and sclerosing properties of the sun rays.

And in the same way as the general sun bath is administered according to the general reactions, so is the local irradiation regulated by a strict control of the focal reactions.

The indications regarding dosage in local lesions depend not only on the situation and the extent of the lesions themselves, but also on all such complications as may be present, because the reactions may vary in each individual case.

The focal reaction varies in its intensity with the vascularity of the affected part of the body, because the richer the vascularity, the more likely it is for hyperæmia to result. Thus in

tuberculous peritonitis very short exposures are sufficient to produce a powerful hyperæmia of the peritoneum, the latter, even in a normal state, being so extraordinarily vascular. This fact explains also why in these cases the sun cure is to be administered, as it were, with a "drop bottle." Similar considerations obtain for the pelvic appendages and for tuberculosis of the bladder. On the other hand, in cases of synovial joint trouble with fungus formation hyperæmia will ensue more slowly in the face of the paucity of blood vessels, which again is characteristic for these parts of the body.

Whilst in the first group of cases it is of utmost importance not to exceed the proper dose, and to prevent violent focal reactions, so in the latter group irradiation can be extended without misgiving (though, of course, not without control), since the risk of congestion is hardly perceptible. In ostitis and periostitis also the reactions appear much more slowly and feebly when the diseased focus is situated within the bone substance, than if it is on the surface of the vascular periosteum. The dose applied to a fibrosed caseating gland will again be essentially different from the dose applied to adenitis when attended with sinus formation, and when the tissues of the skin have already become inflamed.

The inflammatory skin reactions, local hyperthermy, increase of swelling, fluctuation and so on, call for a special watchfulness. Such reactions are to a certain extent normal, since the process of repair consists of a series of reactions. But the latter ought not to overstep a definite limit of intensity. It is the task of the physician to find the right measure for every case, which can only be acquired through long years of study and experience.

Simultaneously with these reactions there appears a profuse perspiration in the vicinity of the lesion; in connexion with this, local hyperthermy sets in, without, however, an erythema being responsible for it. All these symptoms may give rise to a temporary limitation of movements, which, however, gives place to a greater mobility sooner or later. The end-result of the just-mentioned reactions is an intensive pigmentation of the skin covering and surrounding the seat of the trouble. Another effect of insolation produced locally is the abatement

of pain, which, to the patient's mind, is probably the most important of all. I have come across this fact over and over again, and all who have practised heliotherapy have confirmed this analgesic influence of the solar rays.

But, whereas a rationally measured sun bath possesses undoubtedly a high analgesic power, an overdose of sunlight may easily produce an increase of pain, because, as a result of the too intensive exposure, hyperæmia ceases to be limited to the upper layers of the skin and invades the deeper regions.

In certain cases local irradiation may be combined with the full sun bath, both being of the same duration. In others, again, and especially in those with pronounced tenderness of the affected parts, the local treatment is uninterrupted by suitably screening the lesion, and the general sun bath continued.

Temperature of the Sun Bath

No hard and fast rule can be laid down as regards the right temperature of the sun bath which the patients can stand without making any complaints. For here, like everywhere else, individualization is indispensable, and both the general as well as the local reactions, and also the personal sensations of the patients, have to be duly considered and weighed. A strong person, well trained for the sun cure, who is suffering from a closed lesion giving rise to no general symptoms, is able to stand temperatures of anything between 10 and 40° C. in the sun (and even higher still in winter) with great ease. On the other hand, a debilitated individual with infected wounds, or one with internal complications, must avoid extremes of temperature, both high and low, especially at the commencement of the treatment, for they are apt to upset his tolerance and to call forth violent focal reactions. In this class of cases therefore the permissible range of temperature has to be reduced and kept in the neighbourhood of the normal body temperature.

It is true that opinions differ concerning these temperatures. Some authors have tried to classify these baths into various groups. They hold, for instance, that up to 18° C. we are dealing with cold air baths, and only above 18° C. do the sun

baths proper begin. If such a differentiation should be made at all, I would suggest the following reversion : baths up to 18° C. (in the shade) to be called sun baths, and all others to be named hot-air baths.

However, let us take it as a principle that the sun bath ought to create a sensation of comfort on the part of the patient, and consequently it must be modified accordingly; for one person will experience cold, when another will complain of heat at the same time. It follows, therefore, that we cannot fix the temperature of the sun baths in advance, but we must adapt it to individual needs. A doctor who was cured of spondylitis at our place, described a full sun bath of + 8° C. air temperature and 50° C. in the sun as a treat, " because," he said, " the cold air acts stimulatingly and mitigates the glow of the sun, so that only in the evening one notices, by the powerful cutaneous reactions, how intensely it had been burning "; with + 23° C. in the shade and only 45° in the sun he found the sun bath very exhausting.

It is very material to see that the treatment is always carried out amidst relatively cool surroundings, because if the air be hot, this might readily turn into a steam bath, which is fatiguing and depressing, and which, in addition, favours congestion of the inner organs. For this reason treatment should be given in summer between 6 and 9 a.m. (at low altitudes even earlier still), because in this way the best possible results can be achieved.

If it is desired to utilise the more bactericidal and chemical light rays of the spectrum when treating superficial lesions and wounds, these cases can be exposed also between 11 and 12 in the summer time; but only on condition that the sunning is of short duration and frequently interrupted.

In winter, as well, or during the intermediate seasons, the treatment can be kept up the whole morning and even the afternoon, due regard being paid, of course, to the prevailing atmospheric conditions.

2. TECHNIQUE AND CLINICAL RESULTS

A. General Survey.

After twenty years spent on the practical application of heliotherapy, I feel justified in claiming that this method is capable of curing surgical tuberculosis, in all its forms, in all cases, however bad, and at any age. And I shall never weary of repeating the basic principle of this treatment, that " the conception of surgical tuberculosis as a local disease which must only be treated locally, cannot be maintained any longer. Surgical tubercle is a general disease, and as such it calls for a general treatment." Of all infectious diseases tubercle is the one in which the ground, the substrate, that subserves its spreading tendencies, is of paramount importance. Therefore, only such a method of treatment can be regarded as rational and promising which aims at reforming and reconstructing this ground, namely, the body generally.

The methodical application of heliotherapy as recommended by me in 1903, combined with Alpine air, appears to me to satisfy the requirements I have indicated.

The sun bath as a general treatment—that is, the effect of the mixture of sun and air on the total skin surface—is a highly efficacious tonic and the best roborant. As a local treatment heliotherapy ought to stand for a method of choice, because, as we have learnt recently, the direct rays of the sun possess powerful bactericidal and sclerosing tendencies in addition to their analgesic and absorptive properties.

In our sheltered, sunny Alpine establishments we place our most debilitated and miserable patients under conditions which impart to their bodies a more effective means of self-defence than could be possible in the flat country. High up in the mountains this treatment can be adopted irrespective of the seasons, a fact of no mean advantage. The sick people regain their lost vital energy through the instrumentality of the sun and Alpine air. And, after all, one is inclined to give a better prognosis to a person who is full of will-power and the joy of life.

Above all else we replace the human skin into its natural environment, from which it has been alienated for centuries;

it revives, it grows stronger and takes up its proper functions of an important and varied kind with greater ease. Monteunis is right, therefore, in saying : " It is high time that we should make a clean sweep of those new discoveries with their influence on therapy and hygiene which regard the digestive system as the only source of energy in life. This conception is incomplete and falsifies the hygiene of everyday life. Man does not live on bread alone; he feeds on air as well, this being the bread of respiration; over and above the digestive and respiratory nourishment there is also a cutaneous one."

The integument is something more than just a sensory organ, and it has other functions besides elimination; it has, above all, absorptive powers. Apart from such a substantial and essential foodstuff as oxygen, which the skin is capable of absorbing for the body's need, the latter obtains through its integumental cover all those as yet little known substances which become accessible to mankind in a sun and air bath. It is for this, and for no other reason, that the continuous contact of the whole skin surface with sunlight and atmospheric air is credited so generously by me with its refreshing influence on the human organism.

It was this consideration, too, that, to a certain extent, obliged me to abandon the use of occlusive dressings (plaster of Paris, silicate, etc.) in cases of tuberculous bone and joint troubles, these appliances being totally incompatible with heliotherapy.

In 1912 Dr. Plate, in his short contribution to the *Deutsche Med. Wochenschr.*, entitled " Towards the Pathology and Therapy of Joint Trouble," remarks most appropriately : " A joint can only remain healthy so long as it is used. When, however, it is kept still, as the result of either immobilizing bandages or cicatricial changes in the peri-articular tissues, morbid changes in the joint itself soon occur."

This view tallies completely with my experience. Indeed, a plaster-of-Paris dressing robs of sunlight precisely those parts of the body which require it most. Its results are first a decline and then a cessation of cutaneous function, severe anæmia, and not infrequently even maceration of the skin; further, sluggishness of nutrition in all regional tissues combined with

a diminished excretion of metabolic end-products, the intensity of which processes diminishes *pari passu* with the withdrawal of light and sunshine.

If this unnatural condition continues longer still, marked atrophy of the muscles and ligaments occurs, often interfering with their function, a loss which can never be replaced by any mechanical apparatus or appliance, however cleverly constructed.

No wonder, therefore, that we make such haste to set our patients free from their bandages and instruments on their arrival, and to deliver their atrophic limbs, as well as their underfed, miserable, often œdematous and fungous tissues, to the light once more.

We replace occlusive dressings by immobilizing suspension and extension apparatus, which should be as simple as possible, so that, on the one hand, the integrity of the skin and of the underlying tissues should be safeguarded, and, on the other hand, both the local and general action of the sun and air baths be rendered possible. This orthopædic technique, being a most helpful adjuvant of the sun cure, will presently be briefly described.

But before discussing the technique of heliotherapy and its gradual evolution, it seems advisable to say a few words about the housing arrangements of our establishment. A minute description of all the thirty-four Leysin clinics under my care would be superfluous, but I should like to outline their main characteristics. I ought to say at the outset that there is no need whatever to build palaces in order to obtain satisfactory results. The latter as achieved by us in our simpler institutions and also in our popular clinics prove this beyond all doubt. The chief points not to neglect are just a few conditions as to climate, situation, and the plan of the treatment itself.

Reconstruction of a Former Alpine Shelter into a Clinic

When opening my first heliotherapeutic clinic in 1903, I had to hire a " châlet " which then represented the only boarding-house in Leysin. On its south side were erected verandahs

FIG. 1.—The first clinic with children's department. Reconstructed from an old shelter.

FIG. 2.—" Les Chamois." Alpine hotel turned into a sun clinic.

on to which the patients' beds could easily be wheeled. The two wings and the centre part of this small house were arranged so that the patients could spend the whole day in the sun. Since the verandahs on the second floor were too narrow to take the beds, an open solarium was constructed on the south-west side, where the sun cure could be practised all day.

In this house (Fig. 1), which to-day represents one of the popular clinics, most of the cures on which the fame of heliotherapy is based were effected. In spite of its outward simplicity, this clinic may serve as an example to medical men with but small means at their disposal who cannot afford to build expensive establishments, and yet would like to possess satisfactory sun-cure institutions.

Reconstruction of an Alpine Hotel into a Sun Sanatorium

As an example of this type may serve our clinic "Les Chamois," which was originally built as a tourist hotel and is wonderfully situated (1510 m. above sea level). This building, trained to the south-east, had no sun in the afternoon. To remedy this, solaria were erected on each floor on its south-western side. Each solarium is arranged like a theatre box, into which patients can be wheeled on their beds, this being of special advantage in winter. In summer, owing to the south-easterly orientation of the main balconies, the patients can be taken out at sunrise, which again is very advantageous during the hot season.

The Style of a Heliotherapeutic Clinic

As an example in this respect might serve our clinic "Les Frênes," which has one main building and two wings, and which was built specially for the purpose of sunlight treatment. The central structure, with a southern aspect, contains on the ground-floor reception rooms. On the first floor are the dining- and living-rooms, besides service accommodation and other appurtenances; on the remaining floors are bedrooms, with or without balconies, these rooms being mainly reserved for the relatives of and visitors to the patients.

FIG. 3.—" Les Frênes," built specially as a heliotherapeutic clinic.

FIG. 4.—Open balcony.

FIG. 5.—Covered balcony.

FIG. 6.—Solarium "Les Frênes."

FIG. 7.—Children's ward and terrace. "Les Frênes."

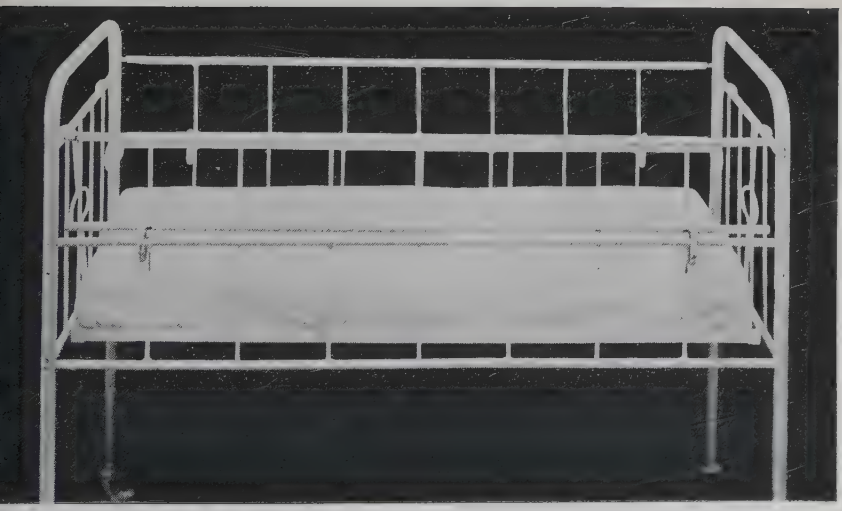


FIG. 8.—Our sick-bed.

On the ground floor of the left wing, which has a south-westerly aspect, are *X*-ray rooms, photographic workrooms, bacteriological laboratories and offices. The upper floors are supplied with superimposed terraces. These terraces have a drawback, for, being exposed to the wind, they can only be used by patients who have already got accustomed to the sun cure. Treatment can begin here early in the morning.

The right wing is placed more towards the south-west, and throughout its whole length is furnished with covered balconies, on to which the beds are wheeled from the patients' rooms. These balconies are better protected, but they have less sun. Each sick-room has its own balcony, separated from the adjoining ones by movable partitions. The first floor is reserved exclusively for children under ten; there are no partitions here, so that the youngsters can enjoy their cure in the company of others.

To obviate the drawback of these covered balconies arising from the fact that the sun at the time of the solstice appears on them rather late, a solarium was built on the roof of the house. This is used for various purposes, being an ideal cure balcony, possessing the maximum of sunshine duration.

The patients can, whenever desired, be isolated by means of simple linen curtains. This solarium is open except for a small portion, which is covered, and reserved for cases requiring more protection. It can also be used as a play-ground, and for those patients who are supposed to perform their first walking exercises on a perfectly level ground it serves also as a walking place. Such a solarium has a great value, and for this reason we build one in all our sanatoria.

As regards the sick-room, again, attention should be paid to its floor. This must be on a level with the balcony, so that the bed can be easily pushed in and out without any jarring or shaking.

The Patient's Bed

Since it is essential to immobilize cases of spondylitis and of arthritis of the lower extremities in a horizontal position, it is obvious that the question of a suitable bed is one of the

utmost importance. Guided by experience, we arrived at a model which can be thus described. It is made of iron, and therefore it possesses great durability (pipes of 27 to

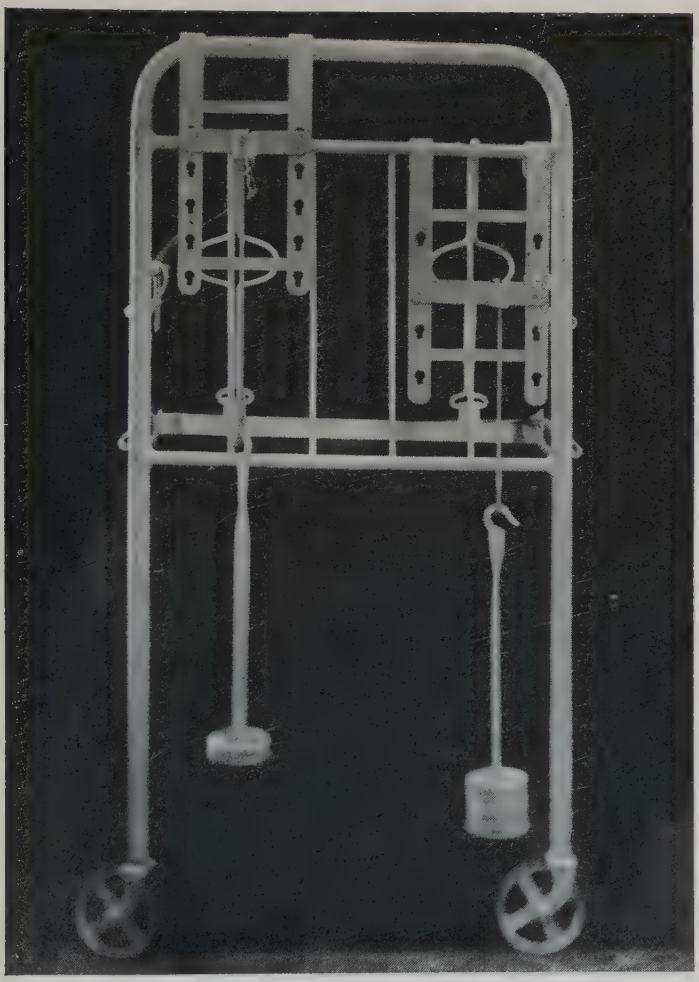


Fig. 9.—Castors and extension.

33 mm.). It is of suitable height—the iron frame, which takes the place of a spring mattress, is 70 cm. above the floor—in order to permit of a free access of the sun rays over the edge of the balcony, and also to facilitate the ministrations

of the nursing staff as well as the continuous control of the orthopædic apparatus. The feet, on ball bearings, are fitted with large castors of 8 to 15 cm. diameter, permitting of silent and easy movements in all directions.

The spring mattress is replaced by an iron frame, the four

Fig. 10.—Our sick-bed with sun screen and adjustable reading stand.

sides of which are fastened together by steel bands. These bands are sufficiently wide apart to ensure a permanent ventilation of the superimposed sea-weed mattress. Thanks to this airing, the latter remains uniformly hard, constantly resilient and flat, thus preventing the sagging of the mattress under the weight of the patient's body. As the sea-weed mattress has to serve also as a splint preventing the formation of

deformities, it must naturally be as hard as possible; pressure caused through sitting up or leaning on it should produce no obvious sagging. Moderately thick and ventilated all round, it has the advantage of being always dry, in contrast with the soft variety of mattresses which enclose the body, hinder the normal evaporation of sweat, favour maceration of the skin and formation of bed-sores and often are the cause of faulty carriage later on.

The details of the bedding may be adjusted according to the seat of the trouble. Our beds are fitted with drop side railings, an arrangement which commends itself especially in the case of lively children.

As to the length and the width of our beds, these vary from 150 × 70 to 210 × 90 cm. At the head end a movable screen can be attached as a substitute for the otherwise indispensable white linen hat, in order to shade the patient's head in every conceivable position of the sun. The screen consists of a four-cornered frame covered with linen. It is fastened to the bed by means of two iron rods, and may be rotated and inclined in every way.

B. Heliotherapy and Orthopædic Measures according to Localization of Disease.

Strict and prolonged immobilization and removal of the body-weight are the general principles of the treatment of spondylitis and of tubercular joint trouble of the lower extremities. Immobilization in a horizontal position fulfils those requirements best. In hospitals and other institutions in the flat country this cure meets with great difficulties, and is often followed by a progressive aggravation of the general condition. In contrast herewith, the patients are able to stand a rigorous immobilization of long duration amazingly well in Alpine sunshine, and, moreover, their general state is vastly improved.

Tuberculosis of the Spine (Spondylitis) [1]

In all cases of spondylitis we combine heliotherapy with horizontal immobilization, until the recovery of the affected vertebræ, *i.e.* as shown by the calcification of the tubercular foci, formation of bone structure, formation of blocks, etc., can be proved by radiographs. Horizontal immobilization is considered indispensable, because it not only affords the spine the complete rest needed for the healing of the disease itself, but also, by relieving it of weight, prevents the further ulceration to which it is liable through compression and deviation. For this reason we condemn all types of ambulatory treatment on principle. In order to attain a proper hyperextension of the diseased segment, our patients are immobilized alternately in the dorsal and ventral positions.

The Dorsal Position

Patients suffering from spondylitis whose muscles are strong and who have not yet developed any spinal deformities, are placed simply on our hard mattress without the use of supplementary cushions. But in the unfortunately frequent cases with pronounced muscular atrophy we find it necessary to interpose a number of cushions between the mattress and the body. Such cushions, filled with millet husk, must be of even consistency. First of all a ring cushion is placed under the pelvis, so that the opening receives the lower sacral and coccygeal regions; in this way the pressure which would otherwise be exercised on the coccyx alone is transmitted to the gluteal and femoral regions. A second cushion serves to fill out the space normally left by the lordosis of the sacrolumbar region. Finally a third cushion supports the shoulder-blades, neck and head.

[1] In order to economize space, extensive quotations from case history sheets have been avoided. A great part of them appeared in the theses and other publications which had been prepared in our clinic. Straube, "Spondylitis." Vodoz, "Coxitis." Giauque, "Knee-joint" (to appear shortly). Leuba, "Foot." Hüssy, "Wrist." Franzoni, "Sequestrum." Kisch and Graetz, "Sinuses." Janecke, "Bone and Joint Tubercle of Old Age." Widmer, "Heliotherapy." Mieville, "Articular Function."

FIG. 11.—Spinal bed.

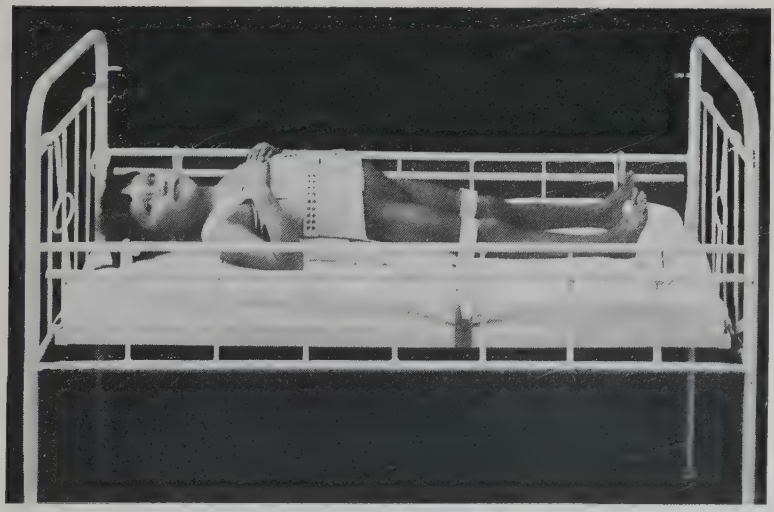


FIG. 12.—Spondylitis in dorsal position.

In the case of children and of restless adults who—especially at the beginning of the treatment—fidget a good deal, we employ also a kind of cloth corsets, which are attached with straps to the two ends of the bed. To prevent the patients from sitting up or from turning over, the upper part of the body is held by shoulder straps.

The above-mentioned cloth corsets are first spread out on the cushions. The patient is placed on top and is then strapped down. We have thus an uninterrupted contact between the whole spinal column from the pelvis to the head established by means of this "cushion-splint," which is an ideal way of fixation. Should the lower extremities also require immobilization, longitudinal belts are affixed and double slings placed across the ankles and knees. It is then sufficient to undo the corsets to obtain a full exposure of the ventral surface of the body to the action of the sun.

When spinal caries is complicated by a gibbus (angular curvature), the diseased section of the spine is placed in hyperextension, and we make an attempt to obtain a gradual reduction of the deformity by applying to it a gradually increasing pressure, yet one that is exercised only through the weight of the patient's own body.

To this end a millet-husk cushion is put, in the first place, under the kyphosis, this being subsequently replaced by a series of sandbags of increasing thickness. The cushions so employed must be even everywhere, so that the spine lies firmly on them throughout its whole length. In this way also lateral pressure will be avoided and the possibility of scoliosis prevented. As soon as the hump has diminished by becoming flatter and the skin covering it has become less sensitive, the sandbag is advantageously replaced by a wooden support with a slight convexity at the top. This support is in the shape of a pine-board 2 to 3 cm. long, slanting above and below, where it touches the body. Across, it must extend from one side of the body to the other, its width being 15 to 20 cm. Wherever a thicker wooden rest is required, we use a wooden block, the profile of which has been made to fit the hunch, and the upper and lateral aspects of which have been perforated so as to allow fresh air to come in contact with the patient's back. As compared with the

sandbag, such a wooden block has this advantage, that it is not apt to lose its main properties of smoothness and dryness, both of which are essential in order to avoid bed-sores, which are inevitable with damp and uneven bedding. Patients soon get accustomed to this firm support, and give it preference over the sandbag and the millet-husk cushion.

The Ventral Position

As soon as the pain has abated —which is usually the case

Fig. 13.—Spondylitis in ventral position.

after a few weeks of the sun treatment —the patients become used to the ventral position. This promotes a desirable lordosis, secures a sufficient immobility of the spinal column and almost abolishes the pressure of the body-weight. In this position there is no risk of the spine suddenly giving way. Further, the irradiation of the whole dorsal surface, and of the affected portion of the spine in particular, is thus rendered practicable. We take the following course :

The patient, who was at first in the dorsal position, is carefully turned over and the cushion or the wooden rest is removed ;

then a wedge-shaped cushion—similar to the bolster commonly used in Switzerland—is pushed under the arms and the chest of the patient. By increasing the height of the wedge-shaped cushion, we obtain the lordotic curve of the spine and are able to increase it according to necessity. In this way even very marked degrees of dorsal and lumbar deformities may be corrected when once developed, and can be avoided if applied in the initial stages of spinal caries.

A patient placed in the ventral position is always inclined to raise his head in order to see what goes on around him, and also in order to occupy his hands with something or other. In doing so he automatically reduces the deformity of his spine. Such reduction appears to me the most natural and the most rational one, because it employs and keeps alert the muscles of the back as well as the dorsal ligaments, in contrast with the customary orthopædic measures, which are mostly detrimental to these two factors, so very important in the maintenance of the erect posture. These movements can in no way be dangerous to the patient, since in the ventral position the vertebræ are relieved of the body-weight. Thanks to this arrangement, the dorsal musculature of our patients develops to an astonishing degree and endows them as it were with natural corsets.

In order to help certain cases to maintain a good lordotic position, we pass round their shoulders straps which, after being crossed behind the patient's back, are fastened to the foot end of the bed. By a gradual tightening up, the shoulders are pulled backwards, whereby the thorax becomes expanded and is thus aided in its development.

Finally the abdominal position may be regarded as being ideal from the physiological point of view, for, thanks to the pressure it exercises on the abdomen, it contributes substantially to a regular action of the bowels.

After a few days' trial the patients prefer it to the dorsal position, and they retain it not only during the best part of the day, but also by night. No mean factor in this connexion is their ability to do all kinds of handicraft, such as writing, drawing, carving, macramé embroidering, sewing on the machine, etc., all counteracting the evils of boredom.

In cervical spondylitis I originally combined the fixation of the vertebral column with its extension by means of Glisson's

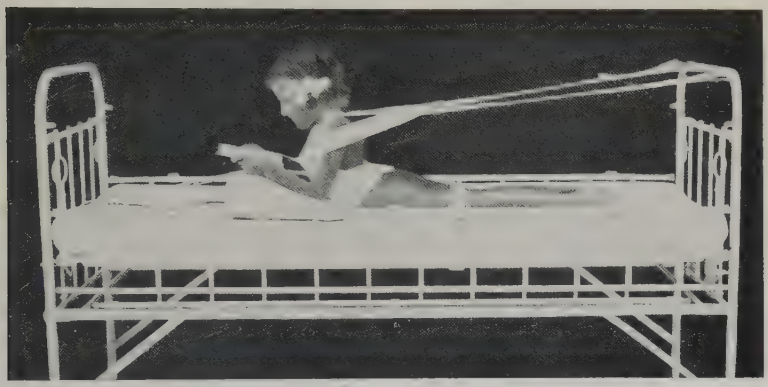


Fig. 14.—Ventral position and shoulder straps.

sling. However, this apparatus may produce—especially in children—bad atrophy of the whole chin region, owing to pressure. This drawback can be remedied by an arrangement

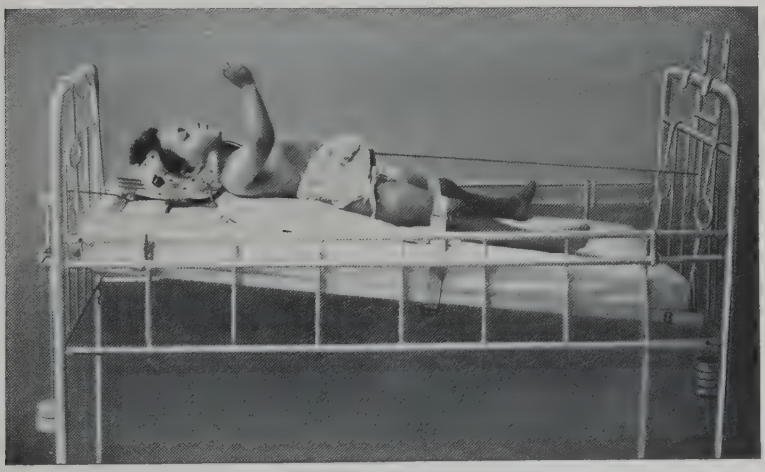


Fig. 15.—Cervical spondylitis with our extension.

which leaves the region of the lower jaw free and finds its point of support exclusively in the occipital region. The application is as follows :

A celluloid shell moulded on a plaster cast to fit the occiput exactly, serves the purpose of holding the head, which remains within it through its mere weight. This shell is fitted with supports sliding to and fro on wheels and rails. This ensures a minimum of friction and a maximum of extension. The traction applies principally to the occipital condyles, moreover it is transmitted in a horizontal direction on to an

Fig. 16.—Patient 12 years old. Extensive caries of dorsal vertebrae with enormous kyphosis. Paraplegia. Atrophy of the muscles. Precarious general condition.

Fig. 17.—The same patient. Complete cure with full correction of kyphosis after 1½ years. (Without the use of plaster jacket.)

extension appliance, which is attached to the end of the bed.

Should counter-extension be aimed at, this may be easily carried out by simply stretching the iron frame which is suspended on hooks at both ends of the bed.

Whilst all patients suffering from closed spinal caries may without exception expect a certain cure from our method of treatment, cases complicated by mixed infection have a much worse prognosis. And because, in spite of all precautions, such complications follow not infrequently upon operations or

faulty punctures, I feel I must warn readers not to undertake surgical measures too hastily in these cases.

Protective Apparatus

Heliotherapy, in conjunction with immobilization in the horizontal position (alternating dorsal and ventral), is to be

Fig. 18.—The same patient taking sun cure in ventral position.

Fig. 19.—The same patient taking sun cure in dorsal position.

continued so long as the clinical evidence of the cure of the local lesion has not been confirmed radiographically. Whenever the disease has spread to several vertebræ, one must wait until the skiagraph demonstrates the presence of a close and compact cicatricial union and strong bony structure, such as would exclude the possibility of a subsequent collapse of the vertebræ. This result becomes manifest one to two years after

the commencement of the treatment, which, as a rule, coincides with the time when the chest and back muscles of our patients have so far developed under the influence of sunlight that they constitute an ideal support for the spinal column.

When the clinical recovery (complete disappearance of spontaneous pain, as well as of pain elicited on pressure applied

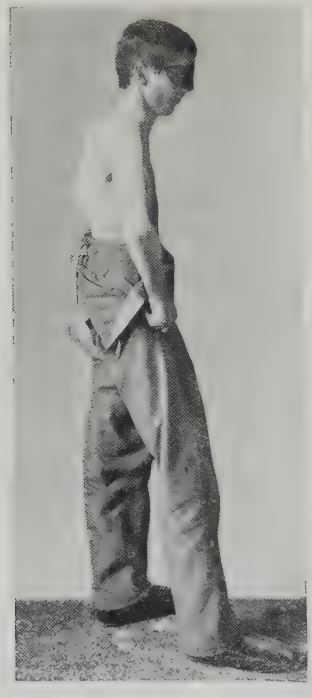


FIG. 20.—A patient of 28. Caries of thoracic spine with general atrophy of muscles; advanced tuberculosis of the right lung; exceedingly precarious general state.

FIG. 21.—The same patient after 1½ years of treatment. Gibbus partially corrected. Muscles strong. Lung much improved.

to the diseased segment of the spine or on tapping along the longitudinal axis, the return of the reflexes, etc.) has been corroborated by the *X*-rays, then only can one think of allowing the patient to get up. In order, however, not to fatigue him unduly by walking and to protect him from the dangers of a trauma, he is made to wear a removable apparatus supporting his spine. The material of which this may be made

FIG. 22.—Patient 9 years old. Spondylitis with angular curvature. Right hip disease with flexion and marked atrophy of the thigh muscles. Peritonitis. Bad general condition.

FIG. 23.—The same patient 15 months later. Spondylitis cured; deformity corrected. Peritonitis and diseased joint healed. Musculature restored.

FIG. 24.—Thoracic spondylitis.

FIG. 25.—The same case as Fig. 24 after $1\frac{1}{2}$ years.

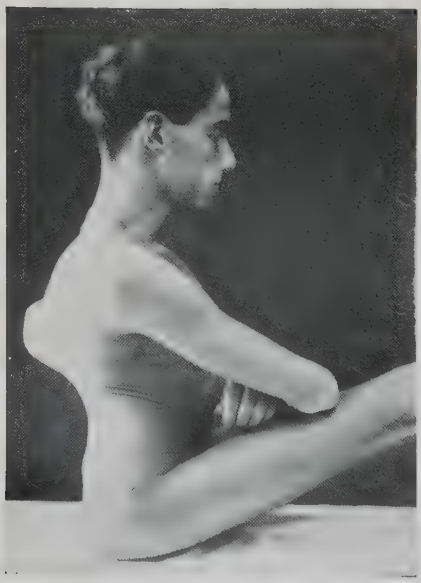


FIG. 26.—Spondylitis thorac. inf.

FIG. 27.—The same case as Fig. 26 after 2 years.

is chosen in accordance with the severity of the case and the extent and seat of the trouble. Being on principle opposed to the use of plaster-of-Paris, I employ either perforated and low-cut-out celluloid corsets, or cloth (linen) jackets fitted with metal rods and arm-pit supports.

The first type is suitable for patients with strong physique, whilst the linen bodices are appropriate for women, young

Fig. 28.—Thoracic spondylitis.

Fig. 29.—The same case as Fig. 28 after 1½ years.

girls and children. Male adults wear celluloid corsets for three to six months and then change them for a lighter transition jacket without metal fittings, which they continue wearing for another six months or so.

These corsets and jackets are all constructed on plaster casts, made to correspond accurately to the shape of the patient's thorax; they do not hinder him in any way, and find their main support on the iliac crests.

After the cure has been accomplished and the reduction

completed, the convalescents must be urgently advised to continue practising the air and sun baths at home as often as possible, whilst also living hygienically otherwise. For nothing

Fig. 30.—Thoracic spondylitis.

Fig. 31.—The same case as Fig. 30 after 2 years.

can better guarantee the maintenance of the necessary powerful muscle corset, and nothing can offer them a better protection against a relapse.

Tuberculosis of the Lower Extremity

(a) Hip disease (Coxitis).

As in the case of spinal caries, so also in hip disease, I have definitely abandoned plaster bandages, because they shut the joint off from sunlight and air, they obscure the appearance of abscesses or sinuses, and they favour atrophy and ankylosis.

Fig. 32.—Dorsal spondylitis.

Fig. 33.—The same case as Fig 32 15 months later.

Sunlight treatment is in these cases combined with continuous extension of the affected leg.

The mattress being absolutely smooth, a hard cushion is placed under the pelvis in order to raise it and, by facilitating complete extension, to counteract the tendency to flexed contracture.

The above-mentioned ring cushion, filled with millet husk, serves to protect the coccyx. Such an elevated position of the pelvis is of importance, because it secures a firm and well-balanced fixation of the parts without interfering with a liberal insolation of the hip and of the trochanteric region.

The mode of extension varies with each individual case.

In cases of incipient coxitis I employ merely a leather or cloth cuff which is applied above the ankle. Should there be, however, need of heavier weights, the apparatus, which might otherwise produce over-extension of the knee joint, is replaced by a double cuff, which consists of two straps (of leather or of some other strong material), one which is applied above the knee and the other above the ankle. Both cuffs are padded inside with cotton wool to obviate irritation of the skin, and are connected with each other by two lateral straps, to the prolongation of which are attached the weights. This contrivance permits us to alter the working points of the extension, for we are able to exercise traction either by means of the upper or the lower cuff, or by means of both cuffs simultaneously.

Pathological rotation is corrected through an extension which acts laterally, and which is applied either above or below the knee and runs over a pulley fastened to the side of the bed. For this purpose again a cloth cuff, padded inside with cotton wool, is buckled round the knee, and to that side of it that is turned towards the lateral edge of the bed a strap is attached.

A very simple pelvic belt is used to assist in the immobilization of the pelvis in restless patients, especially in children, which effects this without pressure on the abdomen. This belt consists of a rectangular band made of elastic stuff in front and some strong material behind, which can be drawn together sideways by means of a cord passed over a hook. This belt is fastened with strong buckles to the edge of the bed.

The above-described double cuff is not suitable for cases with markedly faulty position of the hip which require particularly powerful extension; because in spite of the padding, be it with cotton wool, or be it with stockinette, too much pressure is exercised on the soft parts. In these cases we must rely for extension on adhesive plaster, whereby the leg rests in a light and perforated celluloid or tin splint, which is made to slide on a carriage. Friction of the foot against the bedclothes is thus avoided and a powerful extension obtained. At its extreme end the leg splint is fitted with a movable sole which can be at will drawn up, and which allows thus of the progressive correction of a possible pes equinus.

Abatement of pain in the diseased hip joint is the first

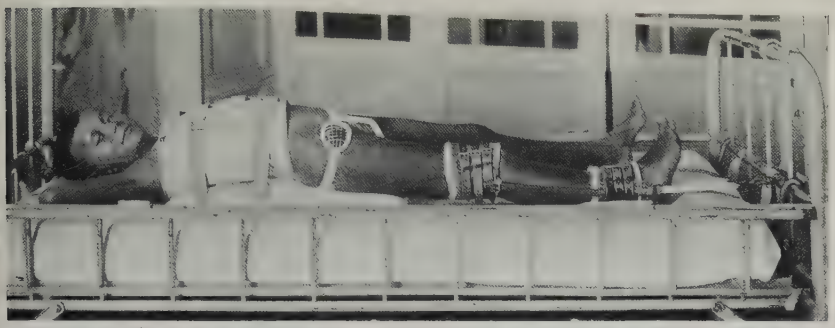


FIG. 34.—Our method of treatment in hip disease. Immobilization in dorsal position with the help of a cloth corset, which, when open, allows total irradiation. Extension by means of a double leather cuff applied above the ankle and above the knee. The latter allows insolation of the legs and thighs. This arrangement permits the working points of the extension to be changed according to need. Note in the groin the presence of a "wire net" which allows uninterrupted insolation and aeration of the sinuses.

FIG. 35.—Hip disease in extension and abduction.

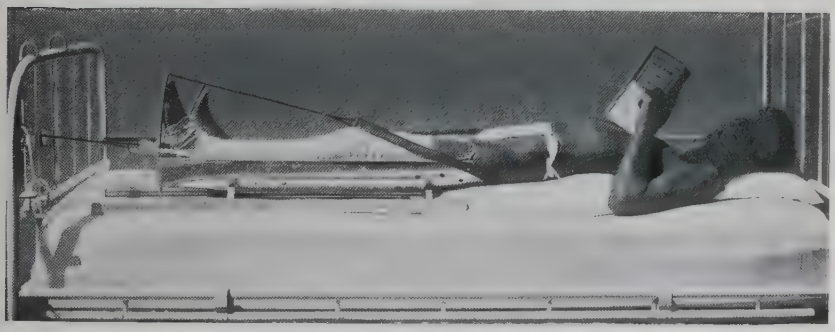


FIG. 36.—Extension on a carriage.

indication of improvement, and is often apparent soon after the commencement of sun treatment. This analgesic action is produced by the de-congestive effect of the sun on the deeper layers and also by the beneficent action of the extension. Finally, it is the improvement in general condition, including the nervous system, and the increased power of resistance of the whole organism that contribute towards the disappearance of the pain.

As soon as it is clinically and radiologically permissible to move the patient without doing him any harm, he is placed in the ventral position for a certain period of time, whilst

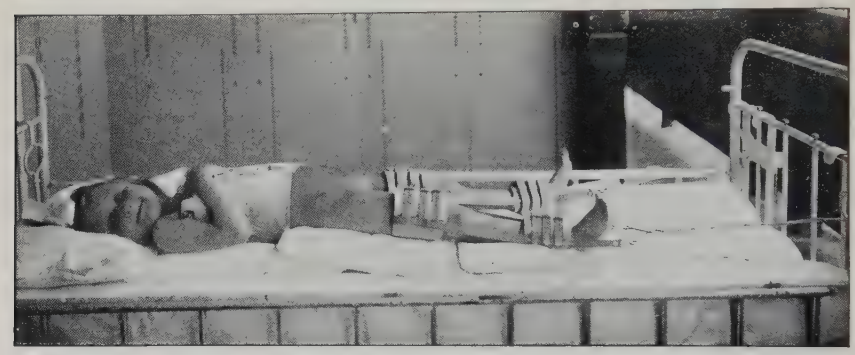


Fig. 37.—Extension in bilateral hip disease.

taking his sun bath. The wedge-shaped cushion is then put underneath his chest, and another plain cushion is made to lie under his feet in order to prevent over-extension of the toes. The ventral position does not in the least interfere with the extension of the affected leg; and it allows of a free irradiation of the whole body, and especially of the posterior aspect of the hip and thigh. With the commencement of recovery, the patients desire to make attempts at small movements. Since it is only in this way that the circulation and the muscles can be improved, it is best to allow them to do so unhindered and in this way to restore whatever mobility there is still left in the affected joint.

Cases of closed coxitis, even if complicated by cold abscesses, heal as a rule completely under the influence of sunlight treat-

ment, because these abscesses show mostly a tendency to spontaneous absorption. All intervention should be strictly avoided, with the sole exception of aspiration as a prevention of spontaneous rupture of the abscess.

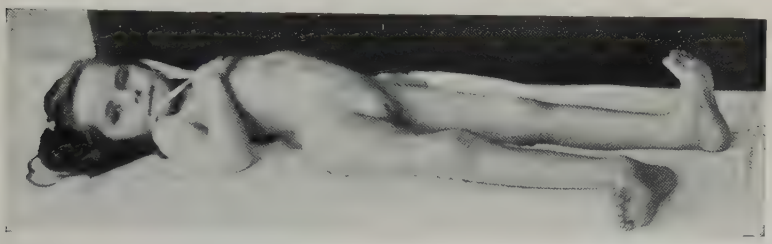


Fig. 38.—A patient of 6. Marked advanced coxitis. Destruction of the head of the femur, shortening and typical position. General atrophy of the muscles.

Fig. 39.—The same case after 1½ years. Position corrected. Recovery of the muscles. Improved general condition.

Fig. 40.—The same patient showing spontaneous return of articular function.

The presence of sinuses which continue to discharge is to be regarded as a serious complication, reducing the patient's power of resistance considerably and exposing him to the danger of amyloid degeneration. Good drainage constitutes here an indispensable condition for successful cure, because it is only

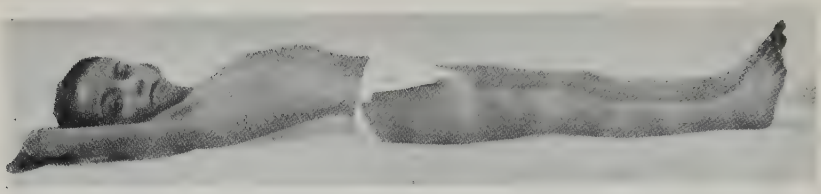


FIG. 41.—Right hip disease.

FIG. 42.—Same as Fig. 41. (Flexion contracture.)

FIG. 43.—Same as Fig. 41 after 15 months.

FIG. 44.—Same as Fig. 41. Function returning.

by an unimpeded, constant evacuation of pus, side by side with a simultaneous improvement of the general state of health, that the sinuses can be expected to close. On the other hand, whenever drainage is interfered with in any way, we see frequent rises of temperature, nausea, loss of appetite, pains, etc., accompanying the periods of pus retention, and acting most deleteriously on the general condition. If each of these periods is followed by a profuse evacuation of matter, order is soon restored. But should a considerable amount of the discharge be retained inside the body, we witness grave effects of toxæmia, leading ultimately to amyloid degeneration.

Retention of pus may be the result of a too speedy closure of the outer opening of the sinus. To avoid this occurrence, the opening is covered with a moist compress after exposure to sunlight. Long sinuses may be kept patent either by the introduction of aseptic gauze wicks or laminaria tents.

Sinuses accompanied by ulcers which discharge but scantily should be covered with aseptic gauze after each sun bath; or, better still, protected by a light, convex wire netting, which allows of permanent ventilation whilst preventing contamination (see Fig. 34).

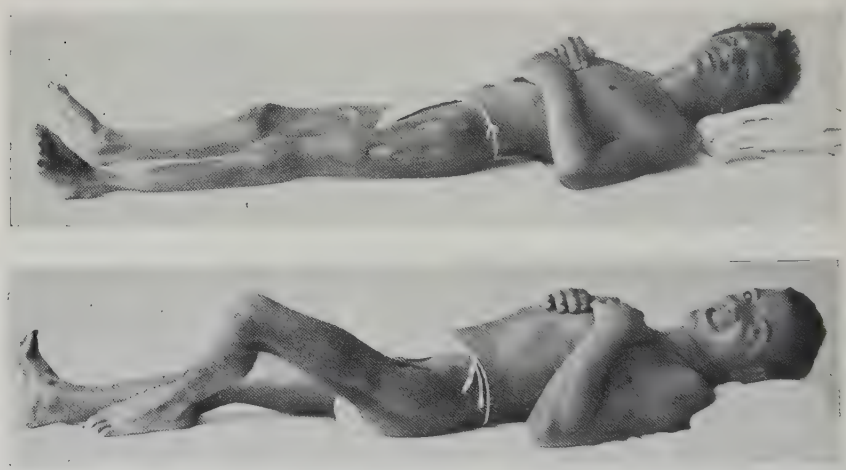
The exposure to sunlight calls forth at first increased secretion of pus. Soon, however, this lessens; it becomes more serous than purulent, then only serous, and finally stops altogether, as soon as the general condition and the local status have correspondingly improved.

In certain instances of hip disease, complicated by multiple sinuses and deep abscesses, the above-described measures prove insufficient to prevent the retention of pus. These are mostly individuals with sinuses opening on to the anterior surface of the thigh and (often) even on to the iliac fossæ. The supine posture renders the free flow of pus impossible, and the patients run a serious risk of amyloid disease. In such cases I feel justified in allowing the patients to get up before their bone lesions have fully healed; for only in this way can the indispensable drainage be properly secured. By this change of posture we have often succeeded in emptying collections of pus with the resulting disappearance of toxæmia, fall of temperature and improvement of both local and general health.

Patients use crutches in these cases, the healthy foot being raised by an orthopædic boot, so that the affected leg does not touch the ground but swings freely in the air, unhampered by any restricting apparatus.

Only in these very special cases do I allow the patients to

FIG. 45.—Bad case of tuberculous hip disease with mixed infection.



FIGS. 46 and 47.—The same patient after 21 months. Disease arrested; striking improvement of general condition and a partial return of function.

assume the upright posture before the end of the cure. For all other forms of coxitis it is the hard-and-fast rule to wait before getting up until the *X*-rays and clinical findings prove a complete recovery of the lesions.

The three characteristic features of heliotherapeutic cure are the striking development of the muscles, frequent return of articular function, and general recuperation.

Fig. 48.—Detail of Fig. 45.

Fig. 49.—Detail of Fig. 46.

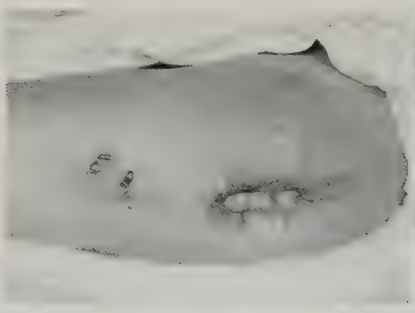


FIG. 50.—Patient of 22, old-standing hip disease with 6 sinuses after operation.

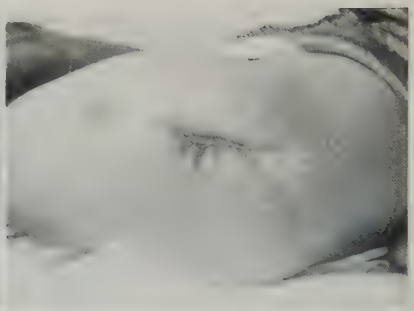


FIG. 51.—Similar case after 10 months. Complete cure of disease and cicatrization of all sinuses.

FIG. 52.—Trochanteritis following operation; sinuses.

FIG. 53.—Same case as Fig. 52 after 1 year.

As soon as the patient is permitted to get up, he is slowly and carefully trained to assume the upright posture, his legs being temporarily protected by elastic bandages in order to obviate a sudden dilatation of blood vessels. His shoes are fitted inside with orthopædic instep supports which help to combat the tendency to flat-foot. The hip joint itself must be protected by a light apparatus, enclosing the pelvis, both hips and thighs; this stabilizes the hip joint during the first walking trials and prevents faulty movements. To avoid lateral bending of the knee the apparatus is prolonged by a celluloid cuff applied to the fibula; this cuff, being fitted with joints, allows of free movements of the knee.

It is helpful to the patient to use long sticks to begin with instead of crutches; since the latter, if used extensively, lead sometimes to spinal deformity. The sticks are held by the user at the level of his shoulders. Security in walking is speedily acquired, so that patients soon learn to discard the sticks and begin to move about on uneven ground.

(b) Tuberculosis of the Knee-joint (Gonitis).

A similar combination of heliotherapy plus extension is employed in cases of tubercular gonitis, or gonarthritis. Here extension favours return of articular mobility. Although this is the rule with cases taken in the initial stage of the trouble, it can also be obtained in cases of unmistakable fibrous ankylosis; and moreover, after the lapse of many years the results are often as good as ever. Just as in coxitis, so also in gonitis, sun cure brings about disappearance of pain and of œdematous and fungous degeneration, favouring closure of sinuses and sound cicatrization.

Whenever a person comes to us suffering from a tuberculous knee at its most active period, and exhibiting a pronounced contracture of the joint, we are content, at first, to place the affected leg in a position of perfect rest, the spontaneous attitude being maintained either by means of cushions or else (which is better still) by using a wide and open splint, which elevates the limb. As soon as circumstances permit, we have recourse to insolation, which reduces pain so rapidly that presently we

pass to the correction of the morbid position of the leg by applying extension.

In most instances a cuff above the ankle is all that is needed for this purpose. Should there be, however, as is often the case, a backward subluxation of the tibia present, then, besides using the cuff, the leg is slung up by means of an elastic bandage to a wooden (or iron) arch spanning over the knee. In this way the

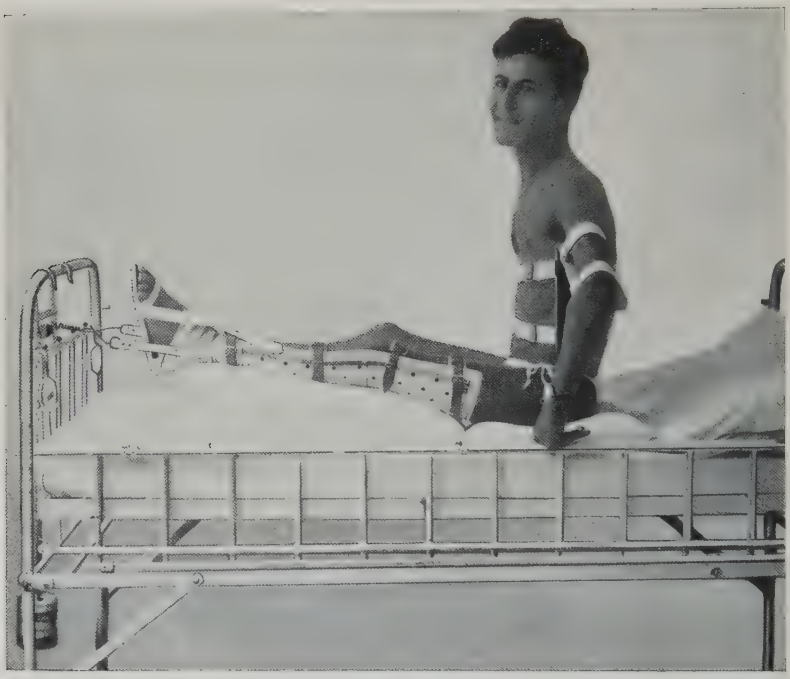


Fig. 54.—Gonitis. Fixation and extension in an open splint.

weight of the thigh, supported by the constant traction of the extension, contributes towards placing the condyles of the femur against the corresponding tibial articular surfaces. If there is marked flexion present, extension should only be made at a slight angle with the axis of the leg, as no patient could tolerate a pull in a direction parallel with the level of his bed, *i.e.* too sudden a correction. The transition to a fully horizontal extension must take place in a most careful and gradual manner, and sometimes the correction of the subluxation and

flexion cannot both be undertaken at the same time. It is of advantage frequently to overcome the subluxation first, and then flexion. In cases of genu valgum or genu varum we practise lateral traction, similar to that used in cases of coxitis, in which there is either internal or external rotation.

Should the trouble have begun in the joint capsule, it is

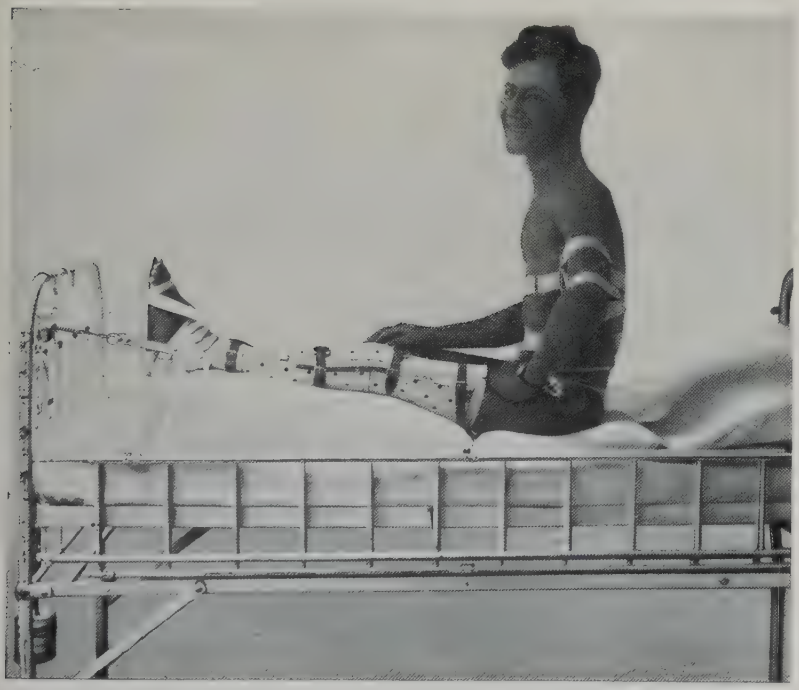


Fig. 55.—Gonitis. The same splint as Fig. 54 with a lid, permitting better fixation at night.

enough to put the leg up in a wide-open splint in a slanting position, so that the foot comes to lie higher than the knee, and the knee higher than the hip. The end of the inclined support in contact with the hip rests on the mattress, and the opposite end, that on which the heel is resting, is raised some 20 to 30 cm. above the level of the bed by a suitable support. Attention should be given to ensure that the wooden plank (covered with a soft material) which serves as the inclined support should be absolutely uniform as regards surface and

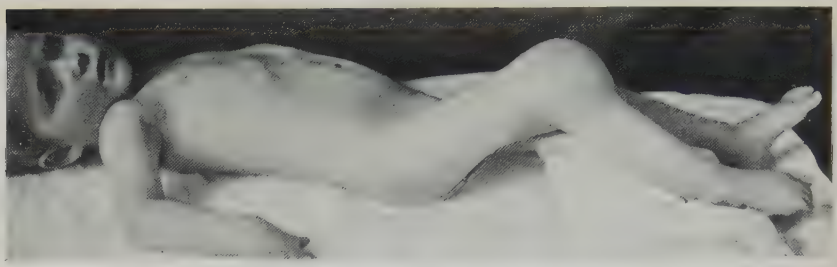


FIG. 56.—Right gonitis. Fixed position; discharging white tumour; sub-luxation of tibia.

FIG. 57.—The same patient showing our method of extension and simultaneous elevation of the leg by elastic traction.

FIG. 58.—The same patient as Fig. 56 cured after 2 years.

FIG. 59.—The same showing the return of articular function.

FIG. 60.—The same patient after 10 years.

FIG. 61.—The same showing mobility of joint.

FIG. 62.—Gonitis resected and fixed with inward rotation; severe mixed infection. Cachexia.

FIG. 63.—Gonitis: Fig. 62 after 2 years.

firmness. This position is of much importance, for it aids the venous return and lessens the œdema and fungating masses by reducing the congestion of the affected tissues.

Fig. 64.—Fig. 62 after 2 years. This patient has been in charge of an agricultural establishment for the past 12 years.

In fungous gonitis we often get good results from acupuncture, periodically applied. The circulation, which is poor even in the normal joint capsule of the knee, becomes much more so when the latter is in the state of fungous degeneration. Acupuncture

FIG. 65.—Patient 8 years old. Left gonitis, muscular atrophy and bad general condition.

FIG. 66.—Recovery of knee after 1 year. Normal outlines. Muscles restored.

FIG. 67.—Complete return of articular function.

FIG. 68.—Gonarthritis with abscess.

FIG. 69.—Gonarthritis, same as Fig. 68 after 15 months.

FIG. 70.—Same as Fig. 69 with partial return of articular function.

induces a hyperæmia of the whole region surrounding the knee joint, and thus contributes to the quick absorption of the diseased mass.

Directly clinical recovery is confirmed by a radiogram the patient is allowed to get up, though the precautions mentioned in connexion with spondylitis and coxitis here also hold good. In some cases it is advisable to let the patients wear for a time a celluloid apparatus to protect the knee joint against injury and harmful movements, this being especially useful when the patient walks. Gradually this apparatus is discarded, this being practicable in the course of a few months, as a rule.

This chapter on the sunlight treatment of tubercular knee joints would be incomplete without some reference to the advisability of resection as practised in adults. At the time of my arrival in Leysin I was myself a supporter of this measure in all cases of gonarthritis, and I have, therefore, undertaken it repeatedly. But soon I came to the conclusion that my zeal was excessive, for in two cases it was found that recovery under the influence of sunlight had already progressed quite considerably and that there was really no justification for resection.

To-day my point of view has changed altogether, and I give preference to the conservative mode of treatment, after having seen its numerous successful results. This change was not a little due to the fact that now and again cases came to me who, after the resection of one knee, developed the disease in the other. Since a bilateral ankylosis would have precluded the possibility of walking, a second resection was straightaway ruled out and a conservative method chosen, so as to obtain a recovery with preservation of a more or less perfect articular function. With one exception only, we have always succeeded in achieving this result, though, of course, it has entailed a great expenditure of patience. Yet this was more than fully justified considering the paramount importance of such results for the patients.

It is quite plain that heliotherapy can cure a recurrence of disease just as well as it can an attack following resection. In my opinion, one should make an attempt at sun cure in every case of gonarthritis, before one decides on surgical intervention.

FIG. 71.—Severe gonitis with mixed infection.

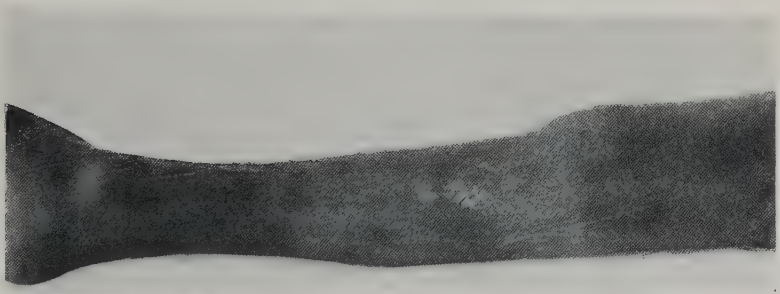


FIG. 72.—Same as Fig. 71 after $1\frac{1}{2}$ years.

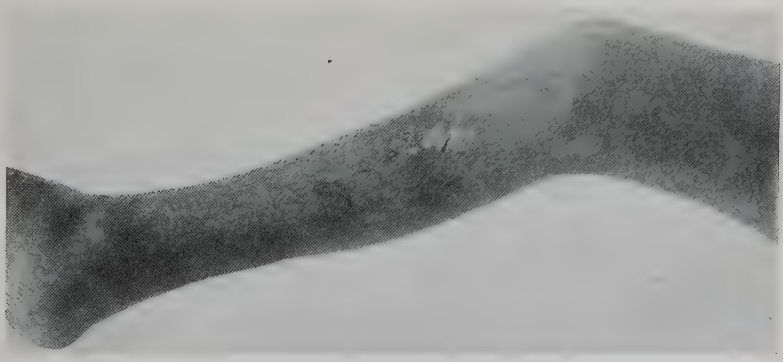


FIG. 73.—Same as Fig. 71. Showing return of function.

An operation is justified in cases of infected gonarthritis as soon as the question arises of how the separated sequestra can

FIG. 74.—Gonitis: operated upon; mixed-infection.

FIG. 75.—Same as Fig. 74 cured after 20 months.

best be removed. The post-operative cavity is then exposed to the direct action of sun rays and progresses speedily to desiccation and ultimate cicatrization.

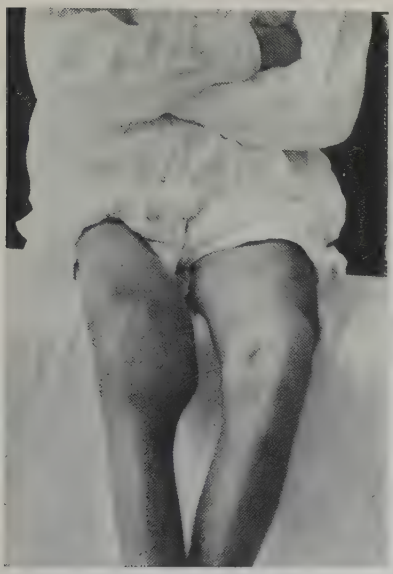


FIG. 76.—Gonitis with abscess.

FIG. 77.—Same as Fig. 76 after 1½ years.

FIG. 78.—Position in tuberculosis of foot. Elastic fixation of sandals to prevent pes equinus.

Cases of gonarthritis attended with destruction of bone and cartilage are in no way unsuitable for heliotherapy. On the contrary, an apparently quite innocent-looking thickening of the joint capsule sometimes offers a much more obstinate resistance—a phenomenon which one is inclined to explain through the faulty circulatory conditions of the articular capsule and its poor defensive properties resulting therefrom.

The argument that the conservative treatment is more tedious and more costly than operation may be met by pointing out the frequency and gravity of post-operative relapses.

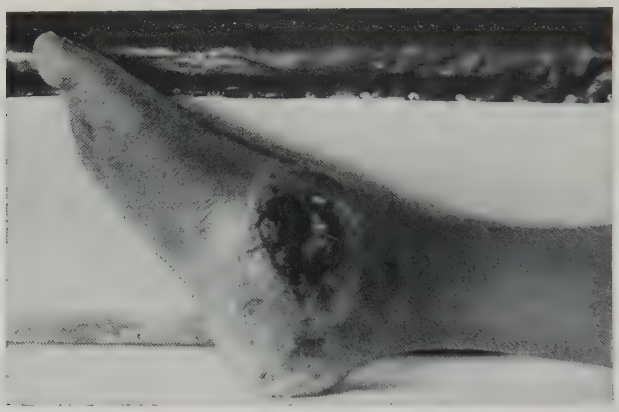


Fig. 79.—Patient of 22. Advanced tuberculosis of foot with fistulous ulcerating tarsitis. Extensive fœtid wound surface.

And, besides, the "work cure," as it is now combined with heliotherapy in our popular clinics (see a later chapter), contributes materially to solve the difficulty of the increased cost of the conservative treatment.

(c) Tuberculosis of the Foot.

When treating tuberculosis of the foot with sunlight, we place the affected part on an inclined plane so as to raise the foot higher than the corresponding knee and pelvis. In order to prevent the equinus position, so common in arthritis of the ankle joint, the leg and the foot are immobilized either in a plaster case or in a celluloid splint. As soon, however, as pain has gone and the condition of the joint permits, the use of the

sandals described above is to be preferred, because they have the advantage of leaving the leg free and preventing muscular atrophy. Immobilization on an inclined plane which favours

Fig. 80.—Spontaneous elimination of the scaphoid.

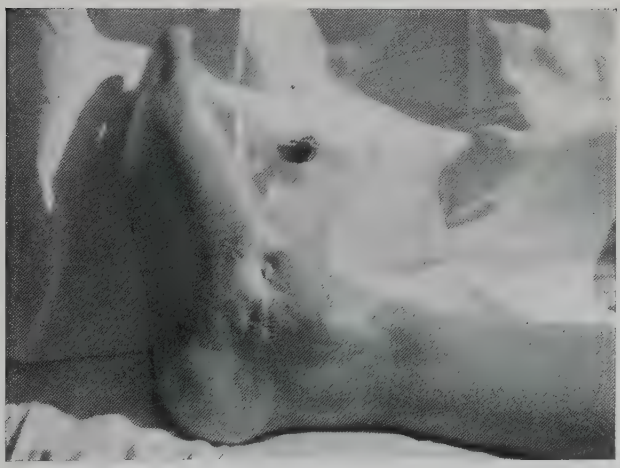


Fig. 81.—Condition after 14 months. Cure with complete cicatrization of wounds after shedding of sequestra.

proper circulation, and permits the absorbing and soothing effect of the sun, makes for the disappearance of œdema, infiltrations and peri-articular swelling.

FIG. 82.—The same patient as Figs. 79–81 after 14 years.

FIG. 83.—Immobilizing celluloid apparatus with adjustable sole.

FIG. 84.—Patient of 20. Tuberculous arthritis of ankle joint with pronounced swelling and multiple fistulæ.

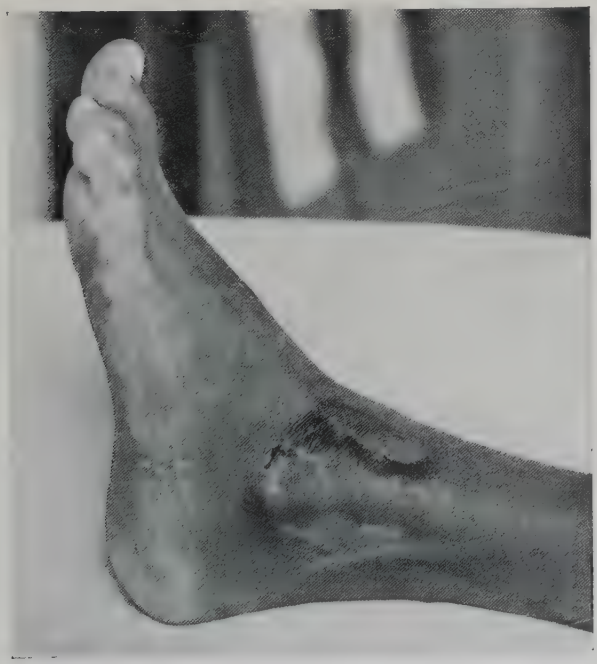


FIG. 85.—Same as Fig. 84 completely cured after 7 months. Full return of function.

FIG. 86.—Patient of 37. Tibio-tarsal arthritis with ulceration and fistulæ.

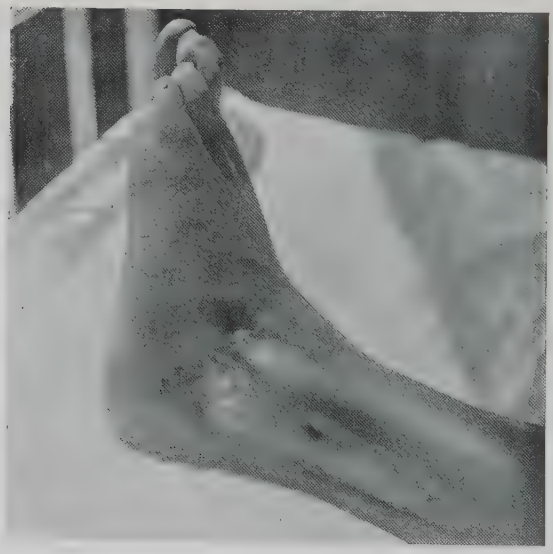


FIG. 87.—Same as Fig. 86 cured after 8 months.

FIG. 88.– Patient of $4\frac{1}{2}$. Advanced tubercle of both feet and of right hand with multiple sinuses and fœtid wounds.

FIG. 89.—The same one year later. Cured.

When the tuberculous foci are situated outside the ankle joint—that is, in the tarsus or metatarsus—movements are allowed to be performed at the healthy joint, in order to stimulate the muscles, which are found to be generally very atrophic on admission.

Should, however, the focus be lodged in the ankle joint, movements—at first slow and gradually increasing—may be

Fig. 90 Severe, septic tuberculosis of the foot.

Fig. 91.—Same as Fig. 90 one year later. Cured.

allowed only when the *X*-rays have confirmed the restitution of the joint. As a rule, joint mobility returns to a greater or less extent.

As soon as the skiagram shows cicatrization in the bone foci, patients are allowed to rise; but only according to the previously described instructions and with the assistance of a supporting apparatus. This consists of a leather shell which grips the leg, and a patten adapted closely to the shape of the

foot—both connected with each other by means of lateral splints. At the level of the ankle there is a hinge which, however, can be kept locked should one consider movements still premature.

The leather legging rests above the knee on both condyles of the tibia, so that the foot hangs loosely inside the apparatus,

Fig. 92.—Progressive abduction splint for shoulder cases.

Fig. 93.—The same apparatus with extension.

whereby all fatigue or pressure on the joint in walking is automatically eliminated.

Tuberculosis of the Upper Extremity

(a) Shoulder Joint.

In cases belonging to this group the weight of the arm alone is often sufficient to reduce counter-extension. We usually try to fix the arm in abduction, so that should ankylosis take place in this position the arm could still be raised to touch the head by means of the scapular movement. Formerly

a three-cornered cushion was employed in order to secure abduction of the head of the humerus and so prevent ankylosis of the joint. Latterly this has been replaced by an apparatus consisting of two perforated boards joined together by a hinge, one of which rests against the thorax, whilst the other supports the arm. The upper piece is fitted with a lever which can be adjusted and fixed in any desired position. This lever engages

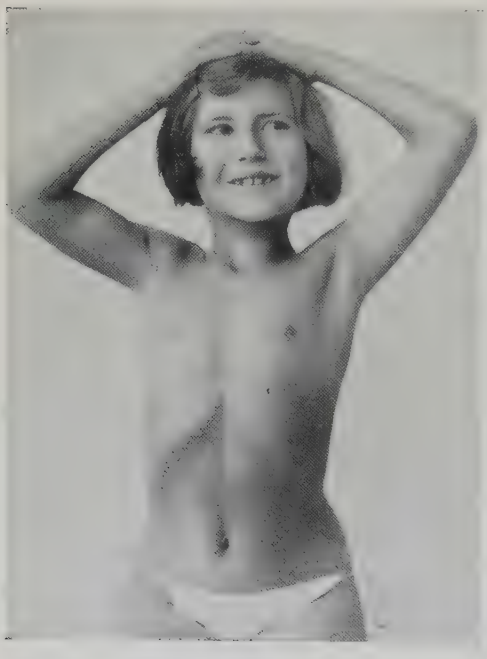


FIG. 94.—Cured tuberculosis of shoulder joint, showing return of articular function.

FIG. 95.—Similar case.

a serrated rod which is attached to the lower piece. Such an arrangement permits of fixation of the shoulder in the best position either straightaway, or else it allows of gradual correction of the bad position. The whole apparatus is buckled to the thorax by means of two straps, one of which runs across the opposite shoulder, whilst the other goes round the chest. At the same time the arm is fastened to the upper splint by two straps. An additional plaster extension may be attached to

this appliance, consisting of a pulley carrying an elastic band which is fastened at the upper wooden board with a leather strap and a button.

The whole apparatus may be made of celluloid from a plaster cast, whereby a better fit is obtained around the thorax and arm. The metal fittings are of nickel-plated steel.

FIG. 96.—Splint for elbow and hand.

FIG. 97.—A similar splint as Fig. 96 flexed.

(b) Elbow and Hand.

In cases of elbow trouble I use with advantage a wide-open splint, which leaves the joint free for exposure to sunlight. With this localization of the disease we obtain better results than with the shoulder joint, and the articular function is here as a rule preserved.

FIG. 98.—Patient 5 years old. Tubercle of face and elbow joint. 17 sinuses after 3 resections. Ankylosis at 160°.

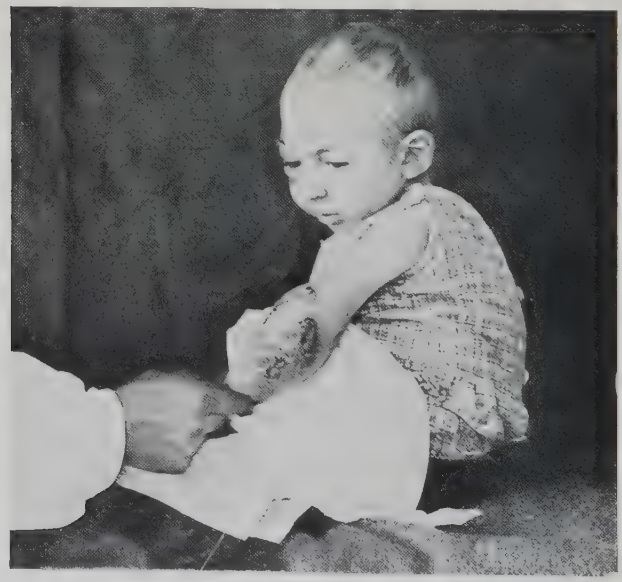


FIG. 99.—Elbow seen from behind : on admission.

FIG. 100.—The same patient. Complete cure after one year. Healing of all 17 sinuses.

FIG. 101.—Same. Return of function.

FIG. 102.—Case Figs. 98–101. 12 years later.

FIG. 103.—Girl of 7. Cubital tubercular arthritis with sinuses.

FIG. 104. Cured after one year.

FIG. 106.—Same case after 14 years: perfect state of health.

FIG. 105.—Return of articular function.

FIG. 107.—Patient of 8. Advanced tuberculosis of elbow joint with numerous sinuses. Separation of a sequestrum.

FIG. 108.—Condition 10 months later. All fistulæ healed, after expulsion of sequestrum.

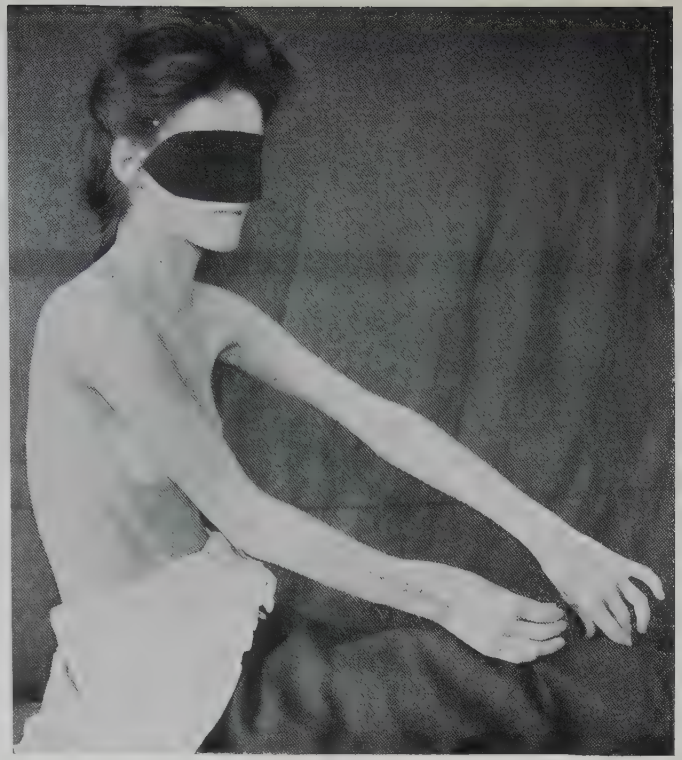


FIG. 109.—Patient of 20. Teno-vaginitis with tumefaction of the wrist. Relapse after operation. Peritonitis, pulmonary tuberculosis. Typical phthisical appearance.

FIG. 110.—Condition after a year. Cure. Normal contours of the joint. Recovery from lung trouble. Splendid general condition.

Tuberculosis of the hand is to be generally regarded as a serious type of localization, at least as far as function is concerned; although there are still many surgeons who, in spite

Fig. 111.—The same patient as Figs. 109–110 after 14 years.

of the discouraging results of resections of the wrist joint, advocate operative treatment. This is all the more regrettable because in these cases the results of heliotherapy are of a most striking character. Like the elbow joint, the wrist joint is amenable to a complete restoration of articular function.

FIG. 112.—Patient of 14. Advanced tuberculosis of wrist and intercarpal joints with much swelling.

FIG. 113.—Cure after 10 months.

FIG. 114.—Patient of 12. Spina ventosa (dactylitis) of the little finger. Elimination of the fungous mass.

FIG. 115.—Same; volar view with two sinuses.

FIG. 116.—Same a year later; dorsal aspect; cured.

FIG. 117.—Same; volar aspect.

Dactylitis (spina ventosa) seldom appears as a separate disease. And as in carpal cases, the prognosis depends on the behaviour of the other concomitant localizations.

In treating hands my plan is as follows. A cup-shaped, celluloid splint, made to fit the forearm and the hand closely, widens out below the palm to allow the spreading of the fingers. A small adhesive plaster extension is applied to the fingers and fastened to the notched cross-piece of the

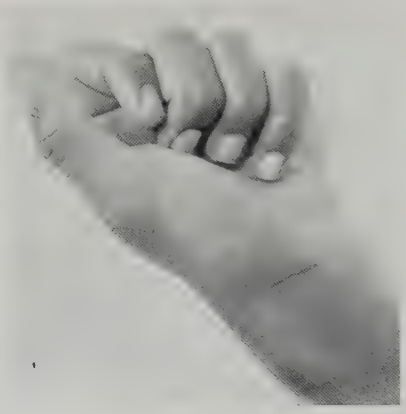


Fig. 118.—Same; showing return of function.

splint. This piece is connected with the extension band by means of a strap passing over a pulley and fixed underneath the splint with straps and a button. This arrangement allows all four fingers to be extended simultaneously.

All that has been said above in respect of the various forms of tubercular arthritis may be applied to tubercular ostitis, periostitis and teno-vaginitis.

Poncet's Rheumatism

Poncet and Leriche, in their book on rheumatism which appeared in 1909, passed the sun treatment over in complete silence. And yet in this rheumatic form of tuberculosis which was so minutely described by the Lyon school, heliotherapy

FIG. 119.—Patient of 12. Active tubercle of both feet, both wrists and hands with multiple dactylitis and tuberculosis of both elbows.

FIG. 120.—Same; completely cured after one year.

may be applied effectively. The technique to be employed follows closely everything said above. The duration of sun baths is regulated according to the resistance of the patient

FIG. 121.—Hand of the same case; protruding flesh-red fungus of plum size.

FIG. 122.—The same hand as Fig. 121 after 7 months. Cured.

and the prevailing circumstances. Should the joints be still painful, they are placed in extension in order to prevent vicious position. When the pain has abated under the influence

of the sun, progressive movements may be undertaken to avoid the notoriously great tendency to ankylosis.

It should be added, however, that there are different forms

Fig. 123.—Patient of 6. Spontaneous elimination of two sequestra. (First phalanx of the thumb and third metacarpal.)

Fig. 124.—The same hand as Fig. 123 cured, after spontaneous shedding of the sequestrum.

of tuberculous rheumatism, so that in reality each patient requires his own method of treatment. It is impossible to lay down rules for the treatment of so polymorphous an affection.

In all cases which came under my care I have been able to observe favourable results.

Tuberculous Sinuses

It cannot be repeated too often that sunlight treatment of open tuberculosis is much less promising and much slower in action than that of closed lesions. The great risk which attends the opening of tuberculous lesions, especially when deep-seated and accompanied by abscesses, consists in the possibility of infection effected by the invasion of a whole host of bacteria from the surface of the skin. These micro-organisms find a particularly favourable pabulum in tuberculous tissues, and the toxins produced by them are more deadly than those of Koch's bacillus alone. They exercise a deleterious influence on the liver, kidneys and the bowel, and they turn cold abscesses into hot ones, that is, abscesses attended with high fever.

Although the mere presence of a sinus constitutes in itself a regrettable event, yet the gravity of the situation may vary according to the distance between the outer opening of the sinus (or fistula) and the tubercular focus to which it belongs, and according to the likelihood of retention, which depends on the fistulous passage itself. For instance, a sinus in the finger or a sinus connected with the olecranon may be relatively benign, when the tubercular lesion is in direct communication with the surface of the skin, because, owing to the shortness of the track, retention of pus is impossible.

In the case of a lesion situated in the region of the spinal column, however, pus that is here produced and which burrows along the psoas muscle reaches the surface at the upper part of the thigh through a sinus with a tortuous course, some 50 to 60 cm. long. Obviously, the likelihood of retention of matter is in such a condition substantially enhanced, whilst the prognosis becomes much more doubtful.

These dangerous sinuses may be of double origin : they may either arise from spontaneous evacuation of abscesses, or result from surgical intervention, whether an operation proper, or merely an unfortunate aspiration.

Subsequently the activity of tubercle bacilli is intensified by the participation of germs which it is often impossible

to combat. Infection of tuberculous pus spreads with uncommon rapidity, as if it were a medium most suitably prepared for the development of these secondary organisms. The cold abscess becomes in reality transformed into a fully active, hot abscess, the products of which are being absorbed by the surrounding tissues, and this absorption leads to symptoms of general toxæmia, followed only too often by amyloid degeneration.

Pelvic tuberculosis with ilio-sacral localization, if closed, may be cured by sunlight with certainty even if it is complicated by cold abscesses. But this favourable prognosis is altogether changed the moment these benign cold abscesses have turned, through spontaneous rupture, into the dangerous infected variety. Draining of the deep niches of the ilio-sacral joint becomes then almost impracticable, and the result is a continuous suppuration with endless retention. In spite of bad results and miserable prognosis, these cases are constantly sent to us after previous surgical interferences had been attempted, which sooner or later mean the certain death of the patients.

In order to combat retention in the sinuses and fistulæ belonging to large joints (hip, pelvis, vertebral column), the most perfect system of drainage must be striven for in the first place.

It is dangerous to bring about a premature superficial cicatrization of the sinuses, for this would have as a consequence retention of discharge in the fistulous canals and labyrinth-like passages, as well as absorptive toxæmia. To prevent premature superficial closure of sinuses, their entrances are covered with damp tampons, or else laminaria tents are introduced into them which swell up and ensure the free flow of discharge. Later on introduction of drainage tubes is recommended. Also, the patient is so placed in his bed that the sinus comes to lie lowermost.

After the above preparations, the sun treatment proper may begin. At first the sinuses discharge more profusely; and the painless and spontaneous separation and elimination of bits of fungous tissues, necrosed tendon sheaths, and sequestra from the size of the finest sand to that of complete small bones (*e.g.*

FIG. 125.—Multiple tuberculosis with sinuses.

FIG. 126.—Same as Fig. 125 a year later.

os naviculare pedis) are effected. Under the influence of the sun foci become cleaned up and an intensive process of repair prepares the way for recovery. Sometimes it happens that new collections of pus form and empty themselves through newly-formed sinuses, which drain better than the old ones.

Fig. 127.—Same as Fig. 125 after 13 years.

These symptoms do not point to an aggravation of the disease : on the contrary, they are attended with an improvement of the general condition as well as with a striking diminution of pain. Over and above this, they prove that the healing process begins deep down and reaches the surface gradually. It follows that the final closure of the sinuses only becomes

possible after the deep-seated focus of disease has gone on to recovery.

As soon as the discharge has ceased and the sinuses become dry, nothing but a small elastic scar remains as the almost invisible trace of the colossal work of reconstruction, which has taken place under the influence of the sun.

Heliotherapy and its results as applied to surgical tuberculosis have led us to a different method of treating abscesses, whether closed or complicated by sinuses and secondarily infected. Aspiration used to be regarded as inevitable in cold abscesses. Thanks to heliotherapy this intervention has become superfluous in most cases, because, owing to the powerful absorptive action of solar rays, these accumulations of pus which originate in bone lesions gradually regress and completely disappear.

In my opinion a cold abscess is often a source of natural immunization and thus has a beneficial influence on the whole body, helping its recovery. In this sense we are allowed to speak of it as of " Pus bonum et laudabile."

Tuberculous lesions of the spinal column nearly always lead to the formation of abscesses, which, *e.g.*, in the case of thoracic vertebræ, are only very seldom accessible to the trocar; this fact, however, in no way precludes a quick and satisfactory recovery. So why should not this hold good with regard to abscesses of the lower dorsal and of the lumbar vertebræ, which offer an easy access to aspiration in the iliac fossæ? In any case puncture of a cold abscess is not rendered necessary by its mere presence, and we advise intervention only if it threatens to rupture, or does not become smaller, or even if, after partial absorption, it remains stationary. But even this simple intervention must be carried out only according to fixed rules.

The choice of the exact site of the puncture is of the utmost importance for the subsequent result. Careful swabbing with alcohol and painting with iodine are very useful. I use the finest possible aspiration needles. As a local anæsthetic a 1% solution of novocain is injected, though this is often superfluous, because the hardened and pigmented skin feels the passage of the aspirator no more than it does the hypodermic needle.

Pus is then evacuated by suction. In contrast to those who advocate other methods, I seldom inject antiseptic substances into the abscess cavity, and then only if the state of the skin makes me fear spontaneous rupture. The puncture is covered with a gauze swab, which is fixed in position with either adhesive plaster or collodion, and the small opening thus soon becomes obliterated. The treatment is in no way interrupted, and two days later the dressing is removed and the site of the puncture again exposed to the sun.

Fig. 128.—Patient of 15. Tuberculosis of knee and ankle joint. Operated five times; 13 sinuses. Ankylosis of the knee joint.

This procedure is practically the only surgical measure I adopt in cases of external tuberculosis.

Since I commenced occupying myself with the systematic sun treatment of surgical tuberculosis, I have seen a large number of cases of spontaneous separation of sequestra, in various situations. Under the bactericidal influence of light, combined with the desiccating action of the germ-free air, the wounds become covered with healthy granulations and the sinuses dry up; the sequestra reach the surface spontaneously and become expelled, and after this cicatrization takes place.

FIG. 129. Same as Fig. 128 after 1½ years. Recovery of all sinuses and of the knee joint. Improvement of general condition.

FIG. 130.—Same case. Return of joint function. Became later one of our best nurses.

In some patients of mine with numerous wounds and sinuses which had discharged sequestra, this process of elimination was most striking and I believe it to be hitherto unknown so far as

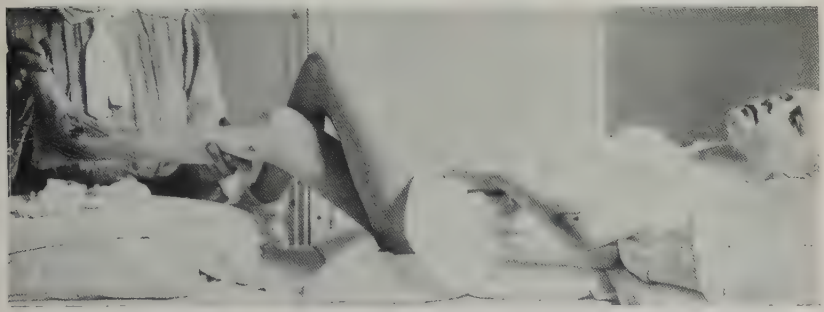


FIG. 131.—Patient of 10. Multiple articular tuberculosis with sinuses following operation. Very bad general state. Muscles greatly atrophied.

our literature goes. Under the influence of sun cure all portions of the skeleton may be found to expel sequestra, this being most frequently the case with the foot, hand, wrist,

FIG. 132.—Same patient after 2 years; fully cured. Perfect general condition and complete return of flesh.

elbow and vertebral column. The elimination *in toto* has been observed only in the small bones of the extremities, but sequestration as such is more common in the long bones than

FIG. 133.—Patient of 13 with multiple tuberculosis. Multiple foci of ostitis, periostitis, adenitis. Very precarious general condition. View from the right side.

FIG. 134.—The same patient cured after 6 months. General condition splendid.

FIG. 136.—Same patient cured.

FIG. 135.—Same, on arrival, as seen from the left.

in the flat ones. This elimination is so interesting a phenomenon of the natural self-protection of the organism, that it is well worth while to describe it more fully.

A freely discharging sinus suddenly shows in its depths a small black spot, resembling a blood clot. This grows bigger and rises to the surface, pushes apart the edges of the sinus

Fig. 137.—The same patient as Figs. 133–136 after 15 years.

and finally appears not unlike a kernel or a stone set in a ring. Its colour is either dirty-grey or black-red; its outline is rugged, and the whole might also be likened to a piece of coal. Gradually and without any difficulty this object is expelled and proves to be nothing else than a sequestrum.

If, on account of bad weather, insolation has to be interrupted, pieces of bone substance which were in process of

extrusion have often been seen to withdraw into the depths of the wound. This proves that the sun takes an active part even in the process of expelling sequestra.

Similar conditions have been observed in cases of tuberculous adenitis, in which glands *in toto* have reached the skin surface in a like manner. This, it might be added, is just as painless as it is complete. The deeper parts of the wounds are preparing themselves to heal up all the time that this expelling process is going on, and the opening closes up within the shortest imaginable time after the disappearance of the sequestrum.[1]

Tuberculosis of the Peritoneum and of the Pelvic Appendages

If there is one local manifestation of tuberculosis which requires general treatment more than any other, it is undoubtedly tubercular peritonitis. It is almost always a sequel of a lesion of either lung or pleura. And indeed, in most of my cases, I have discovered remnants of pleuritic exudates or pulmonary foci, either fresh or partly healed.

A purely local treatment would, under such circumstances, hardly appear to be rational. The operative intervention that is still so much in vogue with many surgeons completely fails in a large number of cases. It creates a local trauma which leads to a weakening of the general health, and so often gives rise to a flaring up of pleuritic and pulmonary lesions. But in the fibro-adhesive type the operation positively does harm when it results in perforation of the intestine and the formation of fæcal fistulæ.

The practice of intervention is here all the more to be condemned because peritonitis, owing to its localization, is particularly suitable for irradiation, no matter whether we have to deal with the purely exudative, fibro-adhesive, or caseating form of this complaint. Yet this very peritonitis calls for the greatest caution in the application of sun cure. Exact control of even the most minute symptoms of reaction is here indispensable if unpleasant mishaps are to be avoided. These

* Sequestrotomy is undertaken only when the sequestrum is " enclosed " and appears susceptible neither of expulsion nor absorption.

reactive signs vary with the particular form of the malady. In Leysin can be seen all kinds of peritonitis, beginning with the discrete tubercle accidentally discovered during an appendix operation, and finishing with the voluminous ascites with a protruding umbilicus, or an extensive infiltration of fibro-adhesive or caseating nature which invades the whole of the peritoneum.

On account of the possibility of circulatory disturbances in

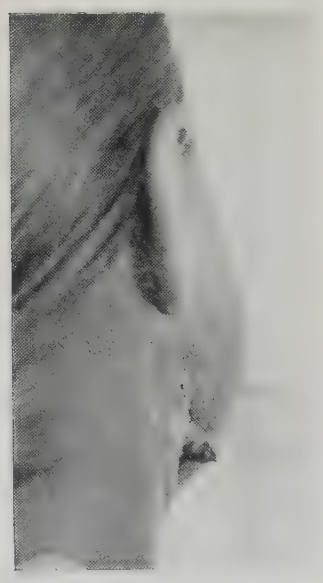


Fig. 138.—Patient 17 years old. Suppurative, fistulous ostitis of the right lower jaw with spontaneous elimination of a sequestrum.

Fig. 139.—Same, cured after 3 months.

the peritoneum, it is of utmost importance that in the last-named group of cases sun treatment should proceed with the greatest care. For several weeks running, the patients have to be subjected only to the secondary influence of the sun bath, through irradiation of the lower extremities. Only after this should the insolation of the abdomen be started, and that only for a few minutes at a time. Whilst this, what might be termed the "drop-glass administration," makes the pain

disappear with much regularity, a too rapid pushing of the treatment, or too long a duration of the sun bath, is apt to provoke increased tenderness through congestion.

The local irradiation, given in careful doses, cures the peri-

Fig. 140.—Advanced tuberculosis of the peritoneum and pleura.

Fig. 141.—Same as Fig. 140 cured after one year.

toneal lesions, while the insolation of the whole body in conjunction with the exposure to the Alpine mountain air raises the general condition of the patients. During the first period, which may last from ten days to several weeks, they are being accustomed in their beds to a more and more continuous air

bath, taken on the balcony at day-time and in the bedroom at night-time, the windows being left wide open. Even during this preliminary period of acclimatization to the high altitude a fall of temperature is seen not infrequently, especially in cases which have been running a regular sub-febrile temperature. In others, although the complete disappearance of fever is not brought about quite so soon, it is possible to restore the balance of strength and thus to arrest the progress of the disease.

The exact moment when the sun treatment proper may be begun must be chosen according to the then prevailing conditions, and can be determined only by the attending physician, after consideration of the temperature chart, the pulse, the appetite and the blood changes. The first sun baths, carried out according to the above-described technique, allow us to form an opinion as to the degree of the patient's tolerance. From the very first there must be a strict control of the oscillations of temperature and the local reactions produced by irradiation, since the subsequent course of the treatment depends on these. The guiding principles of heliotherapy as applied to this serious localization of tuberculosis are precisely the same as for lesions of the other internal organs.

One can readily observe that the purely exudative form of peritonitis can be cured particularly quickly. Extensive exudates often disappear after a few weeks, no matter whether they be fresh or chronic relapsing cases. The disappearance of the exudates is accompanied by an improvement of digestion, and the assimilation of food, as shown by the progressive increase of body-weight, becomes more complete. The disappearance of ascites is the first sign of recovery in other forms of peritonitis attended with the formation of exudates.

The treatment of the fibro-adhesive form which shows a great tendency to recovery gives equally good and lasting results. Cases with disseminated peritoneal nodules, perihepatic, pericæcal and genito-urinary manifestations are favourably influenced. Thickening of tissues and fibro-plastic masses disappear. The intestines become mobile once more, owing to the relief of adhesions even where they have occasioned a partial obstruction of the gut.

FIG. 142.—Tubercular peritonitis.

FIG. 143.—Same as Fig. 142 cured after one year.

The pain becomes less after a very few exposures and disappears altogether as time goes on. This is, of course, the most important symptom to the patient, for it is pain that so often defies all other kinds of treatment. This was observed right at the commencement of my heliotherapeutic work and I have seen it constantly confirmed since.

All our patients who exhibited signs of caseating degeneration had been sent to us after previous operation. The laparotomy scars usually broke down after a while, if they had not already given way soon after the operation. Caseation, which so easily leads to ulceration, renders the prognosis materially worse. At first the caseated masses become softer and the resulting pus finds outlet by the abdominal wound or through an intestinal fistula, when evacuation cannot be undertaken by puncture. This is followed by softening and subsidence of the abdominal swelling, where a hard, lumpy mass had previously been palpable. In these cases we expect much from the general sun bath, which is directed towards improving the general health and the resistance of the whole body.

In respect of tuberculous tumours in the ileo-cæcal region, it can be said that they simply disappear under the absorbing influence of treatment.

All forms of peritonitis, whether operated upon or not, have thus the best chance of cure. Failures have only been recorded in cases of far-advanced general infection, with a simultaneous affection of the bowels which dominated the clinical picture even more than the peritonitis did.

In certain instances of caseating or fibro-caseating peritonitis the effect of sun cure may be increased by the application of the *X*-rays, especially when the absorption is seen to take a long time. This adjuvant is of as much use here as it is in adenitis and epididymitis.

What was said in connexion with peritonitis applies also when the trouble involves the pelvic appendages, which are so often the starting point of peritonitis in women. It is most desirable that recourse should be had to our treatment in these cases as a matter of course; and that it should be adopted in all instances of incipient adnexitis before the disease has time and opportunity to spread to the peritoneum. In this way

FIG. 144.—Patient 15 years old. Bad ileo-cæcal tuberculosis and peritonitis. Operated 3 times (resection and entero-anastomosis) 5 sinuses, 3 fæcal fistulæ, of which one—in the right iliac fossa—discharges fæces through its opening within the wound, which is 8 cm. long.

FIG. 145.—Same patient 10 months later. Completely cured; cicatrization of all fæcal fistulæ.

it is certain that in a large number of cases the outbreak of peritonitis could be prevented, and at the same time the function of the appendages preserved.

Here again is the analgesic power of the solar rays—when carefully used—an extraordinary one. The effect of the cutaneous hyperæmia brought about by insolation is the decongestion of the deeper organs and the total disappearance of the pains so frequently unbearable in pelvic inflammation. We see the absorption of infiltrations, indurations and adhesions taking place little by little, whilst the interrupted or very irregular menstrual periods resume their normal course.

Tuberculosis of Lymphatic Glands

A systematic removal of tuberculous glands is not only a seriously disfiguring process, worthy only of past ages, but it is altogether a physiological absurdity. As is well known, the complete excision of inguinal or axillary glands must give rise to lymphatic stasis in the leg or the arm, and lead to chronic œdema or elephantiasis in the affected limb. It is true that the extirpation of cervical glands does not necessarily lead to a complete arrest of lymph circulation, because there are collateral lymph channels available; yet one must not overlook that paramount anti-bacterial activity of the glands which enables them to serve as an efficient filter interposed between the oral and pharyngeal mucous membranes as the ports of entry of the bacilli, on the one hand, and the central lymph apparatus, on the other. And it is well known that a tuberculous gland does not by any means cease to function, but retains its property of arresting the progress of micro-organisms.

By removing this important barrier one does not merely favour the progress of the germs, but actually opens to them various doors to the circulatory system. Relapses after operation are therefore by no means rare, as is shown by the numbers of patients sent to us after unsuccessful surgical interventions. In addition, the operative method has the drawback of leaving disfiguring scars behind, whose situation,

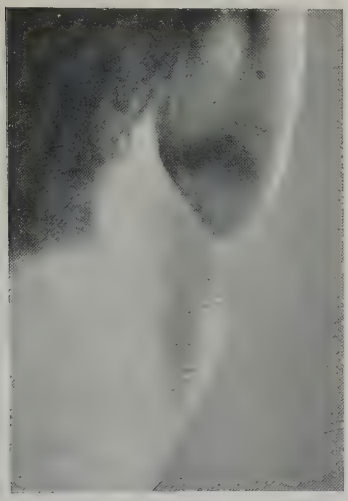


FIG. 146.—Patient of 20. Suppurating sub-auricular adenitis.

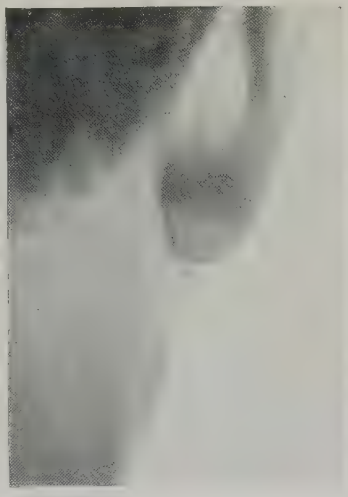


FIG. 147.—Cured after 3 months.

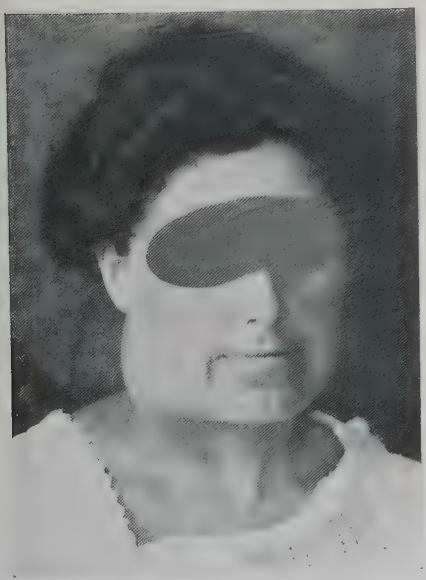


FIG. 148.—Female patient of 30. Voluminous adenitis. Third relapse after 3 operations.

FIG. 149.—Same case cured after 5 months. Spontaneous absorption.

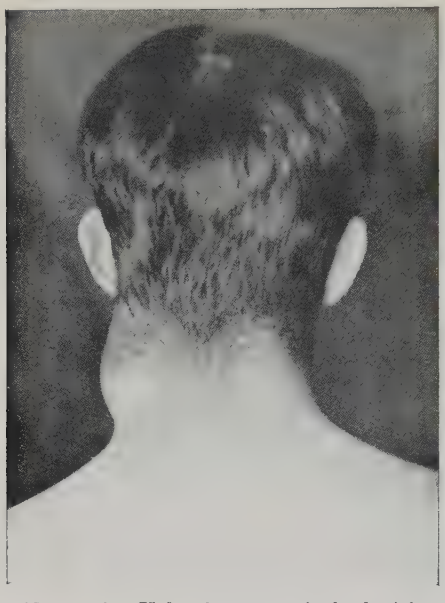


FIG. 150.—Voluminous cervical adenitis.

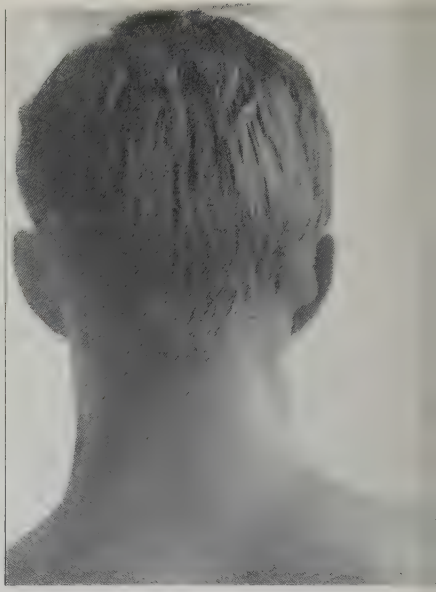


FIG. 151.—Same as Fig. 150 cured after 5 months

FIG. 152.—Sub-maxillary adenitis.

FIG. 153.—Same as Fig. 152 cured after 3 months.

FIG. 154.—Suppurative ulcerative tuberculosis of cervical glands.

FIG. 155.—Same as Fig. 154 cured after 5 months.

FIG. 156.—Fig. 154. Lateral view.

FIG. 157.—Fig. 155. Lateral view.

as, for example, in the submaxillary region, frequently prevents their concealment.

If only for this reason, therefore, heliotherapy should be regarded as the treatment of choice in cases of tubercular adenitis. But over and above it has the great advantage of

Fig. 158.—Female patient of 29. Cervical adenitis with suppuration and sinuses. Spontaneous elimination of the gland *in toto* after 2 months.

Fig. 159.—Same case, cured, showing the state of the wound eight days after the elimination of the gland.

assisting the lymph circulation by the decongestive influence of solar rays; and this in turn enhances the self-protective powers of the glands. In the majority of cases these factors permit an anatomical and functional restitution to take place.

There are more ways than one in which the recovery of adenitis takes place. The inflammatory process inside the

glands usually subsides, no matter whether the case be one attended only with tubercular proliferation or with an already established caseation. Sometimes, though much more rarely, the absorption is only partial, and the result is either calcification of a portion of the caseated tissue or sclerosis. These two types of recovery are especially characteristic of poly-adenitis.

Complete absorption is also the ultimate result with voluminous, hardened glandular masses which have been immobilised through peri-adenitis. I recollect a case of a female patient where a gland the size of a tangerine disappeared entirely after a five-months' sun treatment. Elsewhere, indurated glands, the size of a plum on admission, have been seen to become soft after the lapse of a few weeks. Also spontaneous and complete absorption of the cold abscess may follow on such a softening of the gland. In other cases, again, where the abscess threatens to rupture, it is sufficient to perform 1 to 2 aspirations in order to bring about its disappearance without leaving any scars behind.

The absorptive and softening power of solar irradiation is evident in the case of deep-seated glands as well as in the superficial ones.

An interesting phenomenon sometimes observed in the course of the treatment of tuberculous glands is the spontaneous elimination of true glandular sequestra.

This fact deserves particular mention in inveterate, discharging cases. It is by no means rare for the deep-seated gland, fixed by peri-adenitic adhesions, to become loose under the influence of sunlight, then, free from its fibrous capsule, to make its way along the sinus canal towards the opening in the wound. If the sun cure be interrupted, the gland disappears again slowly inside the sinus, only to reappear once more when the cure is resumed. By and by it appears in the opening and is discharged not unlike a nut from its shell. A few days later the wound closes, the sole trace of the elimination being an almost imperceptible scar. These cicatrices are characterised by their suppleness and elasticity, so that in this way the subsequent formation of keloid can be prevented. Should, however, a keloid be present, it is treated at the same time, for it always disappears under the influence of insolation.

I have never noticed that sunlight has led to a generalization of adenitis or to any complication whatever. The technique of treatment in these cases is very simple, though a cautiously progressive acclimatization to sun baths according to the general principles is indispensable. Insolation must commence with the lower extremities, before the cervical

Fig. 160.—Protective wire netting.

region is reached and it is advisable to begin with short successive sittings in order to avoid congestion and violent local reactions.

Patients who have carried out the cure conscientiously for 1 to 2 hours every morning are allowed to continue the treatment whilst taking their walks or playing games, provided their clothing is cut low round the neck. Such a permanent exposure of the cervical region to the open air is of great advantage in treating neck wounds and sinuses. In order to secure the uninterrupted access of air to the wound during the night, a

small piece of wire netting is placed over it and fastened round the neck either by a tape or by strips of adhesive plaster.

All covering dressings, which favour maceration and practically stifle the epidermis, are on principle to be condemned; as also are antiseptic remedies and injections which bring about changes in the skin or produce eczema, thus doing the patient more harm than good. Just as little am I inclined to curette glandular foci. In spite of its apparently easy technique, this intervention is not altogether harmless; for it often leads to an inoculation with the tuberculous virus, which may be followed by a general spread of the disease.

Tracheo-bronchial glands are, despite their depth, amenable to heliotherapy, just as other forms of gland tubercle are; a fact which I have many a time seen confirmed by the *X*-rays. Sun cure should in these cases be given preference over all other methods. Such patients, as well as those who are predisposed to tuberculosis by rickets or anæmia, are in reality already the victims of latent tuberculosis, so that neglect of the trouble in a hilum gland may easily give rise to an outbreak of an external or an internal form of tuberculosis, *i.e.* in the lungs. It is in this respect that heliotherapy renders priceless services to humanity as a preventive remedy.

Tuberculosis of Mucous Membranes and of the Skin

Owing to the specific character of the epithelium the conditions for successful direct irradiation are still more favourable in mucous membranes than they are in the skin. Ulcers of the nostrils and of the mouth heal rapidly even with the simplest technique possible. Insolation of the larynx by means of a reflector was at first carried out by Sorgo (Aland) and subsequently by Baer, Kunwald, Weiss, Janssen, Dorno and Alexander and the effect of such treatment on tubercular infiltrations was described as very favourable.

Remarkable results can be also achieved in tuberculous affections of the eye. The palpebral conjunctiva—like all other mucous membranes—tolerates sunlight very well. Positive findings in respect of phototherapy were reported by Lundsgard, the eye specialist at the Finsen institute at Copenhagen, and

what is true of a prolonged phototherapeutic treatment of the conjunctiva also applies to systematic and progressive heliotherapy.

The results attained by direct sunlight applied to the everted (yet covering the bulbus) eyelids are in no way inferior to the

Fig. 161.—Patient of 22. Primary tuberculosis of conjunctiva with secondary adenitis.

Fig. 162.—The same patient cured after 7 months.

results of such treatment in bone and joint troubles. In a short publication (Rollier and Borel, "Héliothérapie de la tuberculose primaire de la conjonctive," *Rev. méd. de la Suisse romande*, April 20, 1912), in which the technique of eye tubercle treatment is laid down, there is mentioned a case of a medical student, who during a post-mortem examination received in

his eye some pus from a tuberculous cavity. He developed tuberculous conjunctivitis in the shape of an acute trachoma with secondary deposits in his cervical glands. By means of sun treatment it was possible to cure his malady without leaving the slightest trace, although the trouble had proved refractory to a variety of other measures.

Jointly with Dr. Borel I have seen complete cures in a

FIG. 163.—Disseminated tuberculous nodules on the palpebral conjunctiva.

FIG. 164.—Same as Fig. 163 cured after 7 months.

large number of cases with conjunctivitis, keratitis with deep ulcers and corneal opacities, tuberculous iritis, and even ophthalmia with iritis set up through tuberculous pus. The cornea cleared up and opacities of the vitreous body completely disappeared.

Heliotherapy, with its quick results, its freedom from subsequent traces of damage, and with its splendid effect on the general health of the patient, presents a sharp contrast with the failures which are unfortunately experienced in connexion with operative measures (meningitis following enucleation,

miliary infection after iridectomy, etc.). I remember an instance some twenty years ago of tuberculous choroiditis with meningeal symptoms which was completely cured by sunlight.

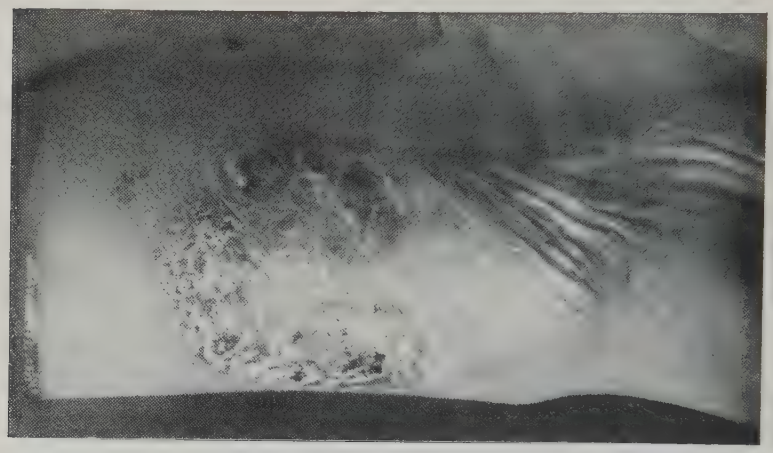


Fig. 165.—Patient of 20. Extensive lupus of forearm.

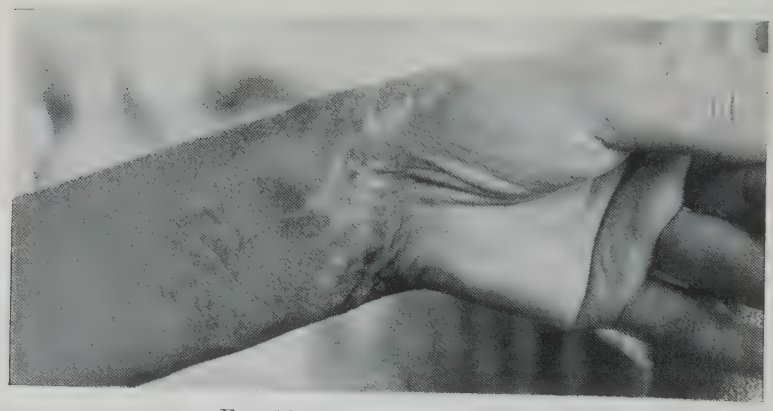


Fig. 166.—Cured after 8 months.

The specific effects of heliotherapy and a much speedier recovery, as compared with classical methods, can be also obtained in the serous forms of tubercular iritis and in cases of eczema of the eyelids and lid margins. This kind of

treatment has never yet led to photophobia or to any other disturbance.

As to lupus, this, owing to its localization, lends itself in a most gratifying way to the application of heliotherapy. Finsen himself was of this opinion, because he wrote (see the reports from Finsen's Light Institute): "Let us not forget the advantages of high altitude when planning photothera-

Fig. 167.—Lupus of face.

Fig. 168.—Cured after 15 months.

peutic institutes or sanatoria for lupus cases. Quite apart from the economy effected by the substitution of sunlight for electric light, one obtains better results at high altitudes than in the low country owing to the increased chemical power of the solar radiation."

Tuberculosis of the Genito-urinary Tract

(*a*) Tuberculosis of the Kidneys.

Unfortunately tuberculosis of the kidneys is never recognised until very late. As is well known, a tubercular lesion may

Fig. 169.—Lupus of face.

Fig. 170. Cured after one year.

have been present in the kidney for many years without making itself at all obvious clinically, and when finally discovered (through the presence of pus or bacilli in the urine), it usually means the bursting of a tuberculous cavity. It may thus be said that the therapy of tuberculous kidney occupies a place peculiar to itself.

Bacilli excreted by the affected kidney infect the ureter as well as the bladder, where gradually more or less extensive and deep ulceration may take place. In the male the infection spreads to the prostate, the seminal vesicles, spermatic cord and epididymis, and produces such changes that it takes a very long time to bring about a recovery. A speedy removal of the renal trouble must, therefore, be regarded as the only rational procedure. And if such patients are advised to submit to sun cure prior to operation, it is because this is intended to improve their general condition, and so help them to bear the subsequent intervention better, and to recover from it more quickly.

The course of renal tuberculosis is notoriously very varied, because besides rapidly advancing cases, we see others that run a slow course. My experience has taught me, however, that under the influence of sunlight the trouble becomes more chronic, which I find useful in cases of bad prostatic tubercle, behind which an unrecognised kidney trouble is so frequently hidden. Cystoscopy frequently entails a grave trauma for the patient, and is by no means without risk; therefore I often wait for this examination until the prostate has quietened down. A careful sun cure is of much value in the meantime as a factor influencing the renal process and reducing the possibility of bladder complications until such time as cystoscopy becomes practicable with impunity.

Even bilateral kidney trouble benefits from sun treatment. It is, of course, impossible to prove this statement with figures; yet there are numerous cases on record in which the morbid process had been unmistakably arrested for a very long time. Often the improvement has been so great that patients were able to take up their occupation again, although they had permanently to remain at high altitudes. The purulent sediment in the urine grew less; micturition became less frequent; and their weight steadily increased.

A secondary affection of the other kidney after nephrectomy is, according to statistics, rather a rare occurrence, complications in the prostate and the epididymis being more common. It is just in order to prevent the formation of these secondary lesions, and in order to cure the obscure tuberculous foci that a carefully adopted sun treatment appears to me to be extraordinarily suitable as an after-treatment following the removal of a tuberculous kidney.

(*b*) **Epididymitis.**

Tuberculous epididymitis, whether unilateral or bilateral, before or after the development of sinuses, reacts in all cases without exception favourably to heliotherapy. Whereas occasionally even tumours of the size of a closed fist undergo an amazingly quick change, and become completely eliminated, either spontaneously or by aspiration of the abscess—in other similar instances great patience is required. From time to time this type of lesion shows a distinct inclination to sclerosis, the central caseating focus surrounding itself with a fibrous layer which grows constantly thicker and thicker.

Although the prospects of recovery are good, the prognosis with regard to the progress of this malady and to the duration of the cure is not easily formulated. Treatment must proceed according to the mode of the healing process. Should it progress either to spontaneous absorption or to suppuration, then there is no case for intervention, because the abscess dries up after spontaneous or artificial elimination of the cheesy substance. In sclerosis, when a caseating nucleus is found imbedded in the midst of a fibrous layer, it is recommended (should the patient's condition remain stationary) to open up the mass by means of the actual cautery and subsequently to cauterise the focus, which is then exposed to the action of direct sunlight. In this way we are able to avoid total epididymectomy.

Pulmonary Tuberculosis

Although pulmonary tuberculosis, strictly speaking, does not come within our purview, we have had to deal with it ever since the beginning of our practice, because in many instances

of surgical lesion there is also a concomitant affection of the lungs.

But although by careful examination it has been possible to prove the presence of lung trouble in a very large proportion of our surgical cases, yet these foci have often been found to be latent, and even where there have been any active signs present, they have proved to be of a markedly benign character.

Experience has taught us that in patients with simultaneous bone and lung trouble, the rapid forms of pulmonary tuberculosis are relatively rare. These persons are partially immunised through the evolution of their bone and joint foci. On the other hand, the prognosis of the surgical trouble may be rendered less favourable by a simultaneous affection of the lung.

Marfan pointed out that it is impossible for an individual who has suffered from suppurating glands before he was fifteen to succumb to consumption of the lung, and Leon Bernard and Mosselot emphasize the fact that 90% of cases of phthisis have never had any other manifest tuberculous lesions prior to their lung trouble. These observations suggest the possibility of a certain antagonism between these two large groups of tuberculous affections.

Twenty years of experience have convinced me that patients with pulmonary tuberculosis do not suffer in the least from exposure to sunlight. Not once has there been a mishap of any kind; on the contrary, a striking improvement under the influence of the correctly administered sun bath has been the rule in every case.

Consumptive patients may be subjected to sun treatment exactly in the same way as those with surgical tubercle, though caution must be exercised in both. By a very careful acclimatization of patients we have always been able to avoid congestion. Indeed, as a result of the artificially created hyperæmia of the skin, sunshine can be regarded as a remedy which reduces congestion of the inner organs. But in order to carry out this treatment without risk, careful and individualizing indications are imperative, based on consideration of both the clinical and anatomical aspects of the case. This, however, is often attended with great difficulties unless it be preceded by a prolonged observation and study of the case.

With but few exceptions nearly all these patients can be treated with sunlight, because the lesions in their lungs are almost always cirrhotic. The same is true of the fibro-cirrhotic forms of the purely pulmonary cases, which are frequently associated with bronchitis and emphysema.

Cutaneous hyperæmia, lasting for several hours after insolation, tends to diminish congestion in the pulmonary circulation. Stasis, which is so common in chronic fibrous phthisis, chronic bronchitis, bronchiectasis and emphysema, often disappears amazingly in the course of a correctly administered sun cure.

Heliotherapy finds application also in the common forms of abortive tuberculosis, chronic pleurisy, dry pleurisy, and old-standing effusions belonging to this category. It is equally efficacious after operations for empyema, or after thoracoplasty, when there are discharging wounds and sinuses. The latter are induced to heal up more rapidly, and the general state of the patient's health is greatly improved.

On the other hand, sun cure is strictly contra-indicated in all forms of tuberculosis which are pre-eminently exudative in character; thus in all pneumonic, broncho-pneumonic and feverish processes, for which nowadays, besides open-air treatment, the advisability of an artificial pneumothorax is, above all else, to be considered. Insolation may become positively dangerous in these cases, and it is only in old-standing, torpid conditions that cautious attempts in this direction are justified. High temperature, being a sign of activity, should serve as an unconditional contra-indication to sun cure in pulmonary tuberculosis.

Although Malgat, in Nice, has been treating his lung patients with local irradiation since 1904, I am not in favour of this method, being rather inclined to prefer the full sun bath, which lessens congestion and also assists the general health. In short, the sun treatment of adult consumption is often of paramount value by reason of its decongestive action on the pulmonary circulation.

Sight should never be lost of the above-mentioned indications. Sun baths given without strict dosage may provoke hæmoptysis and the formation of fresh lesions even in sluggish and a-febrile cases.

In juvenile patients with pleurisy or hilum trouble, and

with or without discrete affection of the lung itself, heliotherapy is almost always indicated. These cases stand the cure well and give excellent results.

C. Heliotherapy and Diet.

There is a close relationship between the function of the skin as an organ of absorption and the amount of food received by way of the alimentary canal : as the former is increased, so does the latter diminish. Conclusions with regard to their habitual nudity may be drawn from the simple diet of inhabitants of tropical countries, who live in strong sunshine, for by exposing their bodies to the sun they profit by the ready absorption from the air thus permitted.

When it is restored to normal conditions the skin can cope more easily with the requirements of assimilative processes, and play the rôle of increasing the vital energy on which so much of the success of heliotherapy depends.

In the practice of heliotherapy, therefore, rules of diet must be laid down. The patient must be persuaded to reduce the amount of food taken and, above all, restrict his consumption of meat. Heavy viands, game, etc., are strictly banned from our bill of fare. Our patients receive white meat, preferably cold. In summer the diet is planned mostly on vegetarian lines. Cereals (bread, oats, barley, etc.) being extremely nourishing, without being toxic, should form the basis of a rational diet throughout the treatment just as they do in the diet of races inhabiting hot climates. They are well tolerated by patients of all ages and even by the weakest stomachs. Vegetables must never be omitted, because they supply the organism with necessary and easily assimilable phosphates and other salts. Green foods are known to mitigate constipation and to contribute to the maintenance of the calcium content, besides supplying in an inexpensive form the body's demand for magnesium, potassium and iron. Fruit is considered by us to be an absolutely indispensable item of the patient's diet. We see to it that fruit is served at breakfast as well as at supper. If eaten first thing in the morning, its slightly aperient effect is highly beneficial. It is also most refreshing when eaten during the sun bath. Alcohol and tobacco are not compatible with heliotherapy and are, therefore, forbidden.

V. HELIOTHERAPY AND WORK

There was a tendency in the past, when treating tuberculous patients, to neglect the psychic factor, though this has perhaps been affected as much as any other part of their thinking and suffering individuality. It should be remembered that these patients exhibit a kind of psychosis induced by their empty, idle existence, which becomes traditional in most sanatoria.

The complete lack of occupation to which for many years tuberculous patients have been condemned, both in low countries as well as in the mountains, is, in my opinion, a great mistake. Many people perish hereby both physically as well as mentally. Nothing is more demoralising for patients hitherto accustomed to work than to be condemned to a prolonged period of complete inactivity.

"Boredom," writes Dr. Vigné, "is a serious illness, although it does not appear in the catalogue of pathology. In the first place, it represents an illness of the will, a faculty which ceases to act when it has no longer an object. Now boredom results from idleness, and again, by sapping the will-power, boredom interferes with all progress; because in tuberculosis, more than in any other disease, the result often depends on nerve potential, and a strong desire to get well is necessary.

"In tuberculous patients, as with all others, physiological functions are in danger when the law of work is systematically violated, especially since psychic equilibrium itself is based on their activity. Patients who are supplied with methodical and suitable occupation become aware of the return of strength and derive great satisfaction from the regular functioning of their organs and from the adaptation of the human machine to the work performed. They experience joy as well as a desire, nay, a will to live, for if death should be equivalent to absolute rest, then absolute rest should in its turn be also regarded as the beginning of death."

The sun cure is a first and very valuable step forward in this direction, because it exercises on the patient a simultaneous physical and moral influence. On the one hand, a methodical and carefully graduated insolation produces a strengthening effect on the weak by stimulating their vital energy and combating somatic decay; on the other hand, heliotherapy, with the concomitant open-air treatment, arouses in patients a sensation of increased well-being which sustains them, and contributes to the restoration of their mental balance.

Fig. 171.—Working colony for convalescents.

With the sun cure is associated the work cure, the effect of which is similar in character. We were led to it through the sun cure in the following way.

Since we have entirely given up the use of all covering dressings and have replaced them with very simple contrivances which immobilise the affected joint for the time being, we bring about, by means of appropriately graduated muscular exercises of the free joints (and later on of the recovering diseased joints), the development of local and general resistance of our patients. By this is not meant mechanotherapy proper, but only exercises employing various muscles, such as flexion,

extension, rotation of the healthy joints, with the object of stimulating circulation.

The results obtained in this way show that in many cases the progressive and strictly individual exercises are to be

FIG. 172.—Spondylitis. Typing.

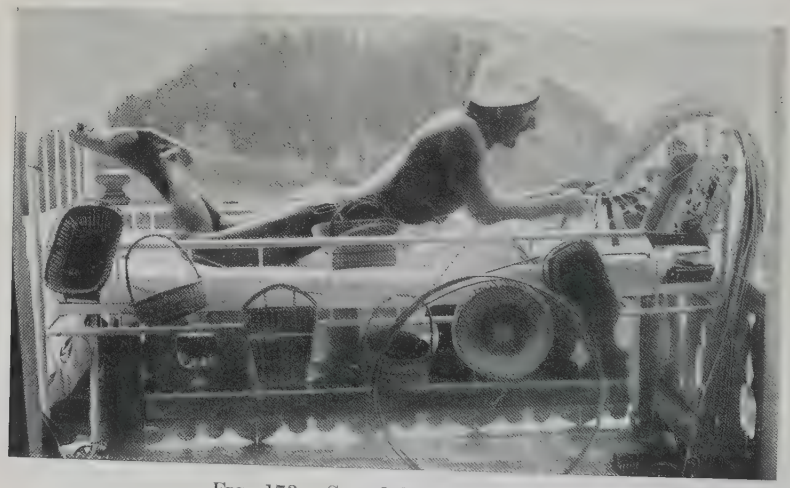


FIG. 173.—Spondylitis. Plaiting.

regarded as a further therapeutic factor in tuberculosis; manual work, the most physiological of all exercises, has become a valuable adjuvant of sun cure. Whilst the latter depends on the weather, the methodical muscular exercises—the work cure—can be carried out in all weathers, and this again helps

FIG. 174.—Work cure in one of our popular clinics.

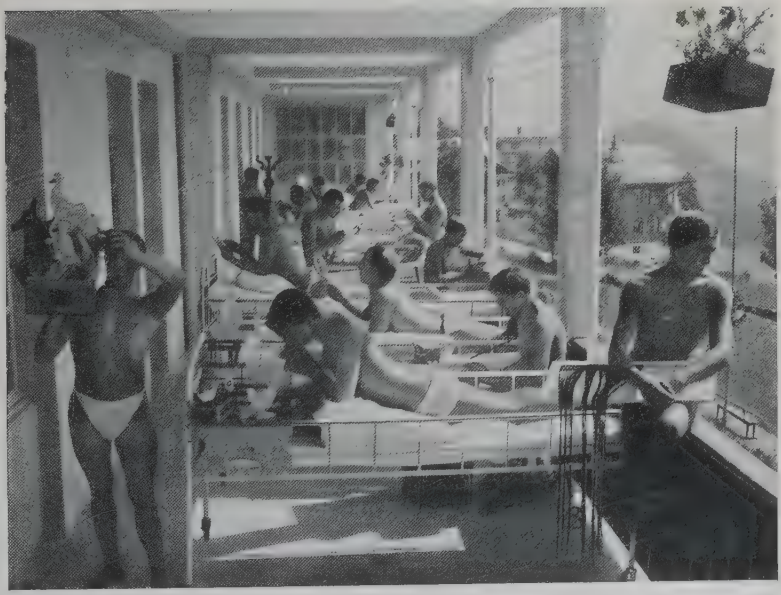


FIG. 175.—Work cure in a military clinic.

patients to fight against the " spleen " which threatens them on grey and rainy days.

Besides its therapeutic and moral aspects, the work cure may also have economic advantages, which to necessitous patients may be of great value.

With this in view I founded in 1909, in co-operation with Rev. Hoffet, the first " Colonie de travail " in Leysin. This aimed at providing non-strenuous occupations for lung or surgical cases which were on the way to recovery, or were already convalescent. These occupations were mainly such as

Fig. 176.—Toy making.

could be practised in the open air or on balconies in conjunction with air and sun baths.

Patients able partly to defray the costs of their upkeep by their earnings lose the depressing feeling of uselessness, they resume their contact with active life, whilst at the same time completing and consolidating their recovery.

With the same object, a small agricultural colony for children was founded in 1910 in Cergnat (Ormont valley), consisting of one living and two farming shelters. The management was in the hands of a farmer, who happened to be an old patient of ours, and who came to Leysin with spondylitis. His recovery was so complete that he could carry on his shoulders very heavy hay-loads without strain or fatigue. The inhabitants of the colony were composed of our young convalescents after

surgical tuberculosis, as well as of feeble and predisposed children, who had been sent to us straight from the lowlands. After a short time they all develop into strong little farmers, who devote themselves to their task with zeal and great regularity.

The " School in the Sun " was combined with the farming colony so as not to neglect the mental development of the children.

The good results obtained in the " Colonie de travail " in Leysin, as well as in the " Farming colony " in Cergnat, encouraged us to try a similar experiment, applying the principle of the work cure to bed-ridden patients who were still a long way from being cured. The success of our experiment was so convincing that we did not hesitate any longer to introduce the work cure as a routine procedure in the Swiss military clinics.

Although at first sight it appears hardly justifiable to allow regular manual work to patients suffering from spinal, hip or knee trouble, in view of their immobilization in bed, yet it was observed that a spinal case could work quite easily in the ventral position, without prejudicing his cure, especially if, after a few months' treatment, the *X*-rays have shown that sufficient progress has already been made. A wedge-shaped cushion filled with hard horsehair is placed under the chest, on which the patient rests his elbows, leaving his hands free. Gradually he becomes accustomed to work for several hours at a stretch without interrupting the treatment directed to his back and the rest of his body. In hip disease a special contrivance permits the patients to work in the dorsal position without the slightest movement of the hip joint, which remains fixed by continuous extension. As far as the knee and foot are concerned, the immobilization and the insolation of the diseased parts are in no way interfered with by the patient's occupation. And even when the trouble is seated in the upper limbs, certain kinds of light work may be carried out in many instances, provided, of course, that the wrists and hands are not involved.

According to the localization of their trouble, patients get used to their work more or less readily. One who is lying on his stomach and resting on his elbows on account of spinal

caries, or one who is suffering from knee or foot tubercle, who can sit upright in his bed, is able to do wood carving, cardboard moulding, tin chiselling, typewriting and light mechanical work, such as clock-making. Cases of coxitis or peritonitis obliged to assume the prone posture are occupied with weaving, crochet, lace-making, and painting on wood and porcelain.

The work cure, like the sun cure, must be devised strictly on individual lines and carefully controlled by the medical attendant, who prescribes for each single patient the kind of work he is to perform and the permissible duration thereof. So long as the patient runs a temperature and is engaged in full fight against the disease, he has not found his physiological equipoise, and therefore the work cure cannot be begun. In the application of the work cure, as in that of the sun cure, the doctor must be supported by a conscientious and reliable personnel. It is equally indispensable that the patients should follow minutely the orders that are given to them.

Over and above its therapeutic and moral value, the work cure has social and economic advantages, which are of particular import in popular sanatoria. Paid work assists this class of patients in a double sense, for besides helping them to regain their physical and mental health, it allows them to a certain extent to pay their way, thus enabling them to continue the treatment until complete recovery is reached. All this is purely a question of organization. The only difficulty presents itself in the finding of a market for the objects manufactured by the patients. This is indeed a knotty problem, though by no means insoluble, for personal observations and the success of the local clinics seem to justify a certain optimism in this respect.

VI. GENERAL CHARACTERISTICS OF SOLAR ACTION

Having discussed the clinical issues, let us in a few words summarise the effect of sunlight on our patients.

The number of bad cases sent to Leysin is considerable, and we have daily opportunity to watch the influence of air and sun on organisms utterly played out. Yet the transformation enacted here under the influence of light within a few weeks is most striking. A body which appeared to have succumbed to tuberculosis without even an attempt at defence rallies its forces. The spirit of life wakes up. Appetite returns. The hæmoglobin content rises week by week. All this means a veritable transformation of the soil, on which tuberculosis can thrive no more, and is the first of the great changes which are ushered in under the influence of sunlight.

Parallel with this obvious general effect, there are also local processes taking place which are of the greatest importance to the patients. The effect of sunlight on the skin has always been interesting. Next to pigmentation, we find an intensive arterial hyperæmia which ensures a better nutrition of the skin and enables it to function normally.

But this intensive blood supply and the more perfect nutrition of tissues are not merely limited to the skin, because they reach the deeper layers and above all the muscles.

Whenever the disease has forced us to immobilise a joint, muscular atrophy infallibly results. Against this there is only one remedy, and this is just sunlight. Under the influence of the sun, which guarantees better nutrition, wasting does not occur, and those muscles which may have already become atrophied recover their volume. This recovery and development of muscles are constant and characteristic phenomena seen in all our patients undergoing sun cure.

Closely connected with the above is the spontaneous return

FIG. 177.—Ostitis of skull.

FIG. 178.—Same as Fig. 177 cured after 6 months.

FIG. 179.—Ulcerative ostitis of the sternum.

FIG. 180.—Cured after 7 months.

of mobility in a large number of diseased joints. This again is highly characteristic of sunlight action. The maintenance of good musculature alone is very conducive to the prevention

Fig. 181.—Ostitis of skull.

of rigid ankylosis. The earlier and more thoroughly the affected joint is subjected to sun treatment, the better will be the functional results. Suppuration and fungation

Fig. 182.—Same as Fig. 181 cured after 1½ years.

become limited through the action of sunlight. Fibrous tissue formed between the articular surfaces and in the joint capsule is less dense, more pliable and allows the movements to be resumed

with ease ; and even when extensive destruction has taken place, useful new joints are created with good functional end-results.

In this manner the recovery of movement is in many instances accomplished spontaneously, without the aid of artificial mobilization. And just as ankylosis follows the complete exclusion of light by plaster-of-Paris bandages, so does the return of mobility follow sun cure.

Much has already been written about the psychic influence of light, and those who have treated hundreds of patients with sunlight have a good opportunity of observing this. A large proportion of our cases are confined to their beds by reason of the nature of their complaint, and bed-ridden chronic cases suffer very often from mental depression, yet a visitor to our clinics would find hardly any sign of it here.

Our treatment exerts the most powerful influence on the psyche of our patients. On our balconies healthy cheerfulness always prevails. And how great is the importance of this from the point of view of recovery I need hardly emphasise.

Being in the sun enables the sick people to regain their old joy in life and brings about a happy elasticity of spirits ; they soon become reconciled with their condition, against which they used continuously to rebel. With the sunshine enter the inward satisfaction and peace which are the beneficent results of the work cure and turn the long sojourn in the mountains from exile into a profitable stay.

Sunlight is, therefore, unmistakably a psycho-therapeutic factor of the first order.

VII. STATISTICS

We have endeavoured to compile as complete a statistical statement as possible, dealing with all cases treated by us since 1903. A first report, published in 1914, was communicated to the International Congress of Medicine at London in 1913; this has been reprinted. The second deals with the years 1914 to 1921.

The reader will be struck with the fact that the results appear to be less favourable in the second period than they were in the first. This is due above all to the fact that the second period coincides with the years of the war and of the disturbed post-war period. Since the beginning of the war a large number of patients have been forced to leave Leysin and return to their homes for family or financial reasons. On account of this fact we find that the proportion of cases discharged as merely improved is larger in the second than in the first report. It should also be noted that since the war we have received a larger proportion of very advanced cases than previously. This is chiefly due to two factors: the difficulty of travelling which caused patients to postpone their journey to Leysin until their condition had become much worse; and the food shortage which made it impossible for many patients to be properly treated in their homes. The proportion of cases complicated by mixed infection was therefore greater than in previous years, and adversely affected the prognosis. Another consequence of the war was a large increase in the proportion of indigent patients, whose number soon greatly exceeded that of patients in more comfortable circumstances, for the great majority of our beds are occupied by patients of the middle and poorer classes, the cost of treatment of the latter being met in part by various insurance societies and charities.

In the clinics where such cases are treated the proportion of advanced cases is lamentable. For instance,

in the Canton de Vaud clinic we find that out of 18 male admissions, one had been ill for twenty years; five others gave periods of twelve, ten, five, four, and three years respectively, and not one of the remainder had been ill for less than one year. Out of 14 women, we had one ill for thirteen years and others with periods of seven, five, four, three, and two years. Out of 14 children three were long-standing cases of seven, three, and two years respectively. But the most extreme figures do not indicate that the disease is incurable, as health may be completely regained in even the most long-standing cases. It is, however, obvious that in cases where the disease has become extremely chronic (owing to the financial impossibility of early treatment), rapid cure cannot be expected, and treatment is apt to be long and proportionately costly.

Speaking generally, the treatment of surgical tuberculosis is bound to be lengthy, because, in the majority of cases, it is necessary, not only to heal the local manifestations of the disease, which are often multiple and widespread, but also to build up a healthy constitution out of material seriously damaged by tuberculosis, and vitiated, more often than one would think, by alcohol and acquired or congenital syphilis.

It has been stated that heliotherapy is only effective with children, but adults have always formed the large majority in the Leysin clinics, and we have found that, with the possible exception of certain synovial types of knee-joint infection and of genito-urinary tuberculosis, the prognosis is not less favourable in adults, and the treatment is hardly longer than is the case with children. We find that out of 2,167 cases of tuberculous bones and joints treated since the outbreak of war, and all controlled by radiography, the following results have been obtained :

Healed : clinically and radiographically : 1,746 (adults 61 per cent., children 39 per cent.).

Improved : 242, of which 79 per cent. were adults and 21 per cent. children.

Stationary : 147, of which 71 per cent. were adults and 29 per cent. children.

Worse : 32, of which 63 per cent. were adults and 37 per cent. children.

In this table it should be noted that those results classed as " worse " comprised, almost without exception, cases of tuberculosis complicated by mixed infection.

It would be difficult to emphasise too strongly the difference in prognosis which exists between closed and open tuberculosis. It would hardly be an exaggeration to say that patients undergoing helio-alpine treatment never die of tuberculosis (on the average, we scarcely have one case of meningitis a year). Mixed infection is almost invariably present when a case terminates fatally, amyloid degeneration or cardiac failure due to toxæmia being the commonest causes of death.

Lest it should be thought that conservative measures, avoiding thorough removal of infected material, should be followed by less permanent results than other methods of treatment, we have recently attempted to compile complete statistics of former cases. Owing to the fact that our patients were drawn from all parts of Europe, this task was necessarily difficult and has, unfortunately, been made quite impossible by the disturbances caused by the war. We have none the less succeeded in procuring information and photographs of a number of our earliest patients whose histories were published many years ago in various medical journals. These photographs, compared with those taken on the arrival of the patient ten or twelve years previously, are particularly eloquent of the durability of the arrest of the disease produced by heliotherapy, and most of them represent cases sent to Leysin *in extremis*. The fact that these cases were almost all drawn from the poorer classes of society, who were consequently forced in many cases to return to unhygienic surroundings, adds not a little to the credit of heliotherapy. Histories of several such cases are to be found in this book.

We should like to furnish more complete statistics than those which follow, but, unfortunately, the present high cost of publication has made it necessary for us to abridge this section as far as possible. Should the reader desire fuller information he will find our complete statistics in Dr. Mathieu's thesis, *L'Héliothérapie de la tuberculose chirurgicale à l'altitude.*

The following statistical data, up to p. 189, refer only to the period 1914–1921, and their arrangement lacks uniformity, because the various localizations have already been dealt with by individual writers in their dissertations. The earlier tables, which appeared in the first edition, will be found on pp. 189–193.

SPONDYLITIS : 370 cases.

I. *Total Results.*

	Healed.	Improved.	Stationary.	Died.
Total percentage	63·5% 235	21% 78	7·0% 26	8·3% 31

II. *Individual Results.*

1. Without Abscess : 56 cases.

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	3	3	1	—	7
6–12	17	3	—	1	21
12–18	12	—	—	—	12
18–24	11	—	—	—	11
24–30	2	—	—	—	2
30–36	2	—	—	—	2
36 and upwards	1	—	—	—	1
Total	48	6	1	1	56
Total percentage of the 56 cases.	85·7%	10·7%	1·7%	1·7%	

Percentage of recoveries after treatment lasting more than one year : 28 cases = 100%.

2. With Abscess : 96 cases.

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	5	3	—	1	9
6–12	7	3	—	—	10
12–18	20	5	1	—	26
18–24	17	4	—	—	21
24–30	14	—	—	—	14
30–36	10	—	—	—	10
36 and upwards	3	2	—	1	6
Total	76	17	1	2	96
Total percentage of the 96 cases.	79·1%	17·7%	1·04%	2·08%	
Percentage after treatment lasting more than one year . . .	83·1% 64	14·3% 11	1·3 % 1	1·3 % 1	77

3. With Abscess and Compression : 43 cases.

	Healed.	Improved.	Station-ary.	Died.	Total.
Total percentage	53·3% 23	20·9% 9	4·7% 2	20·9% 9	 43

4. With Sinus Formation : 96 cases.

	Healed.	Improved.	Station-ary.	Died.	Total.
Total percentage	31·2% 30	32·3% 31	16·7% 16	19·8% 19	 96

5. Spondylitis with Pulmonary Tuberculosis : 62 cases.

Duration of treatment in months.	Healed.	Improved.	Station-ary.	Died.	Total.
0– 6	—	3	2	3	8
6–12	2	5	2	—	9
12–18	13	2	1	4	20
18–24	8	3	1	—	12
24–30	5	1	—	1	7
30–36	5	1	—	—	6
Total	33	15	6	8	62
Total percentage of the 62 cases.	53·5%	24·1%	9·6%	12·9%	
Percentage after treatment lasting more than one year (45 cases).	68·9% 31	15·6% 7	4·4% 2	11·1% 5	 45

6. Spondylitis without Sinus Formation : 274 cases.

Duration of treatment in months.	Healed.	Improved.	Station-ary.	Died.	Total.
0– 6	11	11	5	5	32
6–12	35	15	2	1	53
12–18	58	9	2	4	73
18–24	43	7	1	—	51
24–30	21	2	—	—	23
30–36	19	—	—	1	20
36 and upwards	18	3	—	1	22
Total	205	47	10	12	274
Total percentage of the 274 cases	75·1%	17·0%	3·6%	4·3%	
Percentage after treatment lasting more than one year (189 cases)	84·1% 159	11·1% 21	1·6% 3	3·2% 6	 189

INFLUENCE OF AGE ON PROGNOSIS.

A. *Spondylitis without Sinus Formation :* 274 cases.

1. Children of 15 and less : 89 cases.

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	5	1	2	1	9
6–12	5	4	1	1	11
12–18	15	3	1	1	20
18–24	12	3	1	—	16
24–36	18	—	—	1	19
36 and upwards	12	1	—	1	14
Total	67	12	5	5	89
Total percentage of the 89 cases.	75%	13·4%	5·7%	5·7%	
Percentage after treatment lasting more than one year	82·6%	10·1%	2·3%	4·4%	
	57	7	2	3	69

2. Adults : 185 cases.

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	6	10	3	4	23
6–12	30	11	1	—	42
12–18	43	6	1	3	53
18–24	31	4	—	—	35
24–36	22	2	—	—	24
36 and upwards	6	2	—	—	8
Total	138	35	5	7	185
Total percentage of the 185 cases	75·1%	18·9%	2·7%	3·7%	
Percentage after treatment lasting more than one year	85%	11·7%	0·8%	2·5%	
	102	14	1	3	120

B. *Spondylitis with Sinus Formation :* 96 cases.

	Healed.	Improved.	Stationary.	Died.
1. Children : 30 cases.				
Total percentage (30 cases)	53·3%	23·3%	10%	13·3%
	16	7	3	4
2. Adults : 66 cases.				
Total percentage (66 cases)	21·2%	36·4%	19·7%	22·7%
	14	24	13	15

PELVIC TUBERCULOSIS : 46 cases.

These cases are distributed as follows :

Ilio-sacral joint	25 cases, of which 4 showed, on admission in Leysin, post-operative sinuses.
Ilio-sacral joint and iliac bone	6 cases, 1 of which showed sinuses.
Iliac bone	6 cases, 2 with sinuses as above.
Os ischii	3 cases, all with sinuses as above.
Os pubis	2 cases, 1 with sinuses as above.
Sacrum and coccyx	1 case.
Os pubis and ischii	1 case.
Os ischii and iliac bone	1 case with post-operative sinuses.

Ilio-sacral foci (31) affected the right side in 15 cases, the left side in 10, and both sides in 6 cases.

Of those 31 cases 13 showed also other tubercular lesions.

I. *Total Results.*

	Healed.	Improved.	Station-ary.	Died.	Total.
Total percentage	69·5%	23·9%	4·2%	2·1%	
	32	11	2	1	46

II. *Individual Results.*

1. Without Abscess : 17 cases.

Duration of treatment in months.	Healed.	Improved.	Station-ary.	Died.	Total.
0– 6	2	1	—	—	3
6–12	3	1	—	—	4
12–18	6	—	—	—	6
18–24	3	—	—	—	3
24–30	—	—	—	1	1
30–36	—	—	—	—	—
Total	14	2	—	1	17

2. With Abscess (closed) : 7 cases.

Duration of treatment in months.	Healed.	Improved.	Station-ary.	Died.	Total.
0– 6	—	—	—	—	—
6–12	2	1	—	—	3
12–18	2	—	—	—	2
18–24	1	—	—	—	1
24–30	1	—	—	—	1
30–36	—	—	—	—	—
Total	6	1	—	—	7

3. Abscess with Sinus : 12 cases.

Duration of treatment in months.	Healed.	Improved.	Station-ary.	Died.	Total.
0– 6	—	1	—	—	1
6–12	—	4	—	—	4
12–18	1	—	1	—	2
18–24	1	—	—	—	1
24–30	1	1	—	—	2
30–36	1	1	—	—	2
Total	4	7	1	—	12

4. With Operation Sinus : 10 cases.

Duration of treatment in months.	Healed.	Improved.	Station-ary.	Died.	Total.
0– 6	—	—	—	—	—
6–12	1	1	1	—	3
12–18	6	—	—	—	6
18–24	—	—	—	—	—
24–30	—	—	—	—	—
30–36	1	—	—	—	1
Total	8	1	1	—	10

Average duration of treatment (in months) : 15·8.

Coxitis : 130 cases.

Without abscess	52 cases
With abscess, without sinus	26 „
With sinus	44 „
With sinus after operation	8 „
Total	130 cases

I. *Total Results.*

	Healed.	Improved.	Station-ary.	Died.	Total.
Total Percentage	70·7% 92	20·9% 27	4·6% 6	3·8% 5	130

II. *Individual Results.*

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	6	6	—	—	12
6–12	19	7	2	2	30
16–18	11	3	4	2	20
18–24	16	4	—	—	20
24–30	18	3	—	—	21
30–36	11	2	—	1	14
36 and upwards	11	2	—	—	13
Total	92	27	6	5	130

Articular Function of the 92 Healed Cases.

1. Closed Coxitis.

	Normal.	Reduced.	Ankylosis.	Total.
Percentage	34·4%	41·3%	24·1%	
Cases	20	24	14	58

2. Coxitis with Sinus Formation.

	Normal.	Reduced.	Ankylosis.	Total.
Percentage	11·7%	35·2%	52·9%	
Cases	4	12	18	34

Average duration of treatment (in months): 19·1.

The five deaths occurred in patients of whom 3 showed sinuses and 4 abscesses. The cause of death was:

Pneumonia	1 case
Suppurating pleurisy	1 ,,
Amyloid degeneration	1 ,,
Pulmonary tuberculosis	1 ,,
Miliary tuberculosis	1 ,,

Note.—In the above statistics the presence of illness prior to admission at Leysin is left out of account.

Gonitis: 233 cases.

I. *Total Results.*

	Healed.	Improved.	Stationary.	Died.
Total percentage (233 cases)	71·9%	24%	2·5%	2·1%
	166	56	6	5

II. *Individual Results.*

A. *Synovitis :* 94 *cases.*

1. Without abscess : 85 cases.

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	3	6	1	—	10
6–12	6	8	—	—	14
12–18	20	5	—	—	25
18–24	13	3	—	—	16
24–30	6	—	—	—	6
30–36	11	—	—	—	11
36 and upwards	3	—	—	—	3
Total	62	22	1	—	85
Total percentage of the 85 cases.	72·9%	25·8%	1·1%	—	
Percentage after treatment lasting more than one year (61 cases).	86·9% 53	13·1% 8	— —	— —	

Articular Function after Recovery.

	Complete.	Reduced.	Ankylosis.
Percentage (62 cases)	62·9%	27·4%	9·7%
Cases	39	17	6

Average duration of treatment (in months) : 21·04.
Note.—35·05% of patients showed also other tubercular lesions.

2. With Abscess : 5 cases.

Recovered : 4. Improved : 1.
Articular function of the 4 cured cases : Normal, 1 ; reduced, 2 ; ankylosis, 1.

3. With Sinus : 4 cases (3 of which after operation).
Cured (with ankylosis) : 3. Died : 1.

B. *Osteo-arthritis :* 139 *cases.*

1. Without Abscess : 67 cases.

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	3	3	1	—	7
6–12	5	7	—	—	12
12–18	11	3	—	1	15
18–24	9	2	—	—	11
24–30	7	—	1	—	8
30–36	5	—	—	—	5
36 and upwards	9	—	—	—	9
Total	49	15	2	1	67
Total percentage of the 67 cases.	73·1%	22·3%	2·9%	1·4%	
Percentage after treatment lasting more than one year (48 cases).	85·4% 41	10·4% 5	2·1% 1	2·1% 1	

Articular Function of the 49 Healed Cases.

	Normal.	Reduced.	Ankylosis.	Total.
Percentage	32·6%	38·8%	28%	
Cases	16	19	14	49

Average duration of treatment (in months): 24·03.

2. Abscess without Sinus: 36 cases.

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	—	—	1	—	1
6–12	2	3	1	—	6
12–18	6	4	—	—	10
18–24	6	1	1	1	9
24–36	4	1	—	—	5
36 and upwards	5	—	—	—	5
Total	23	9	3	1	36
Total percentage of the 36 cases.	63%	25%	8·3%	2·7%	
Percentage after treatment lasting more than one year (29 cases).	72·4% 21	20·7% 6	3·4% 1	3·4% 1	

Articular Function of the 23 Healed Cases.

	Normal.	Reduced.	Ankylosis.	Total.
Percentage	13%	26·1%	60·9%	
Cases	3	6	14	23

3. Abscess with Sinus: 36 cases (of which 16 after operation).

Duration of treatment in months.	Healed.	Improved.	Stationary.	Died.	Total.
0– 6	—	2	—	1	3
6–12	3	3	—	—	6
12–18	5	2	—	—	7
18–24	4	1	—	—	5
24–36	2	1	—	—	3
30–36	2	—	—	1	3
36 and upwards	9	—	—	—	9
Total	25	9	—	2	36
Total percentage of the 36 cases.	69·4%	25%	0%	5·5%	
Percentage after treatment lasting more than one year (27 cases).	81·5% 22	14·8% 4	9% —	3·7% 1	

Articular Function of the 25 Healed Cases.

	Normal.	Reduced.	Ankylosis.	Total.
Percentage	24%	12%	64%	
Cases	6	3	16	25

Average duration of treatment (in months): 35·65.

TUBERCULOSIS OF FOOT: 128 cases.

A. *Ankle Joint: 56 cases.*

Of these were:

Without abscess	20 cases
With abscess	9 „
With abscess and sinus	13 „
Post-operative sinuses	14 „
Total	56 cases

I. *Total Results.*

	Healed.	Improved.	Station-ary.	Died.	Total.
Total percentage	78·5%	14·2%	3·5%	3·5%	
	44	8	2	2	56

Duration of treatment in months.	Healed.	Improved.	Station-ary.	Died.	Total.
0– 6	3	4	—	1	8
6–12	13	1	—	—	14
12–18	10	—	—	—	10
18–24	4	2	1	1	8
24–30	6	—	1	—	7
30–36	3	—	—	—	3
36 and upwards	5	1	—	—	6
Total	44	8	2	2*	56

* The cause of death in both cases was meningitis. These patients had open lesions with sinuses and showed cerebral symptoms already on admission.

Articular Function of the 44 Healed Cases.

	Normal.	Reduced.	Ankylosis.	Total.
Without abscess	16	3	—	19
Abscess without sinus	3	1	3	7
Abscess with sinus	2	5	4	11
Sinus after operation	3	3	1	7
Total	24	12	8	44

Average duration of treatment (in months): 17·5.

B. *Other Joints of Foot: 72 cases.*

These were distributed as follows:

Chopart's joint	19 cases
Lisfranc's joint	9 „
Metatarso-phalangeal joint	2 „
Astragalo-calcaneal joint	2 „
Lesions not involving joints	40 „
Total	72 cases

Average duration of treatment (in months): 14.

Duration of treatment in months.	Healed.	Improved.	Died.	Total.
0– 6	13	5	—	18
6–12	17	4	1	22
12–18	9	1	—	10
18–24	8	—	—	8
24–30	8	—	—	8
30–36	5	—	—	5
36 and upwards	1	—	—	1
Total	61	10	1	72
Total percentage of the 72 cases.	84·7%	13·8%	1·3%	

Tuberculosis of Shoulder Joint: 35 cases.

Closed lesions	17 cases
Open lesions with sinus	18 „
Total	35 cases

The head of the humerus and the joint itself were the seat of the trouble in 17 cases; in 3 cases resection had been done; 5 cases had a purely synovial character; epiphyseal lesions were found in 5 cases, and the remaining 5 cases had trouble in the acromion process and acromio-clavicular joint.

I. *Total Results.*

Healed: 84·8%, *i.e.* 28 cases. Improved: 15·2%, *i.e.* 5 cases.

II. *Individual Results of the Improved 5 Cases.*

In 3 cases the length of the treatment was less than 6 months.

In 1 case with multiple lesions it was 12 months.

In 1 case, which had been operated upon prior to his admission in Leysin and which showed numerous sinuses, the length was 11 months. He left us in a much improved condition. The complete recovery took place one year later.

Not one case remained stationary.

Duration of Treatment (in months).

3– 9	8 cases	Cases with less than 3 months' treatment are not quoted here.
9–13	8 „	
13–20	6 „	
20–26	5 „	
26–30	4 „	
36	2 „	

Articular Function of the 33 Cases.

	Normal.	Recovered.	Ankylosis.
Percentage (35 cases)	17·4%	31·3%	51·3%
Cases	6	11	18

Tuberculosis of Elbow Joint: 31 cases.

Of these, 24 cases were accompanied by sinuses and 7 were closed; 6 were synovial types, 24 osteo-arthritic, 1 case of diaphyseal trouble of the humerus with involvement of the joint.

Total Results.

	Healed.	Improved.	Stationary.
Total percentage (31 cases)	71%	22·5%	6·5%
	22	7	2

Duration of Treatment.

In 5 cases this took 1– 9 months
„ 10 „ „ 9–13 „
„ 6 „ „ 13–18 „
„ 7 „ „ 18–24 „
„ 3 „ „ over 24 „

Longest treatment took 72 months (severe malaria).

Articular Function of the 22 Healed Cases.

Perfect . . . . . 8 = 35·3%
Reduced (but still useful) function . . . 9 = 40·9%
Ankylosis (bony or fibrous) . . . . . 5 = 22·8%

Age of Patients (in years).

0–10 . . . . . 5 cases
10–20 . . . . . 12 „
20–30 . . . . . 10 „
Over 30 . . . . . 4 „

Duration of Illness.

In 6 patients less than one year
„ 4 „ 1– 2 years
„ 2 „ 2– 3 „
„ 6 „ 3–11 „
„ 2 „ over 11 „

In 11 cases, owing to insufficient case history, it was impossible to trace the beginning of their trouble.

TUBERCULOSIS OF WRIST JOINT AND HAND.

A. *Wrist Joint: 53 cases.*

I. *Total Results.*

	Healed.	Improved.	Stationary.	Died.
Total percentage (53 cases) . .	45·2% 24	47·1% 25	1·8% 1	5·6% 3

II. *Individual Results.*

(*a*) Bone Lesions.

	Healed.	Improved.	Stationary.	Died.	Total.
Closed	17	19	1	2	39
Open	6	3	—	1	10
Total	23	22	1	3	49

(*b*) Synovial Lesions.

	Healed.	Improved.	Stationary.	Died.	Total.
Closed	1	3	—	—	4
Open	—	—	—	—	—
Total	1	3	—	—	4

Duration of Treatment (in months).

	Bone lesions.	Synovial lesions.
Medium	14	18
Maximum	35	—
Minimum	4	—

B. *Hand: 24 cases.*

I. *Total Results.*

(*a*) Small Joints of Hand.

	Total percentage.
Healed	20%
Improved	80%

(*a*) Dactylitis.

Healed	89·4%
Improved	10·6%

II. *Individual Results.*

Small joints: 5 cases. Dactylitis: 19 cases.

(*a*) Hand Joints.

	Healed.	Improved.	Stationary.	Died.	Total.
Closed	1	2	—	—	3
Open	—	2	—	—	2
Total	1	4	—	—	5

(*b*) Dactylitis.

	Healed.	Improved.	Stationary.	Died.	Total.
Closed	9	1	—	—	10
Open	8	1	—	—	9
Total	17	2	—	—	19

Duration of Treatment (*in months*).

	Small joints of hand.	Dactylitis.
Average	7	14
Maximum	—	39
Minimum	—	5

	Healed.	Improved.	Stationary.	Died.
Total percentage for all cases of wrist and hand tuberculosis (77 cases).	54·5% 42	40·26% 31	1·3% 1	3·9% 3

Ostitis and Periostitis: 81 cases.

I. *Total Results.*

	Healed.	Improved.	Stationary.	Died.
Total percentage (81 cases)	74·07% 60	20·99% 17	2·47% 2	2·47% 2

	(*a*) Closed : 35 cases.			(*b*) Open : 40 cases.			
	Age of the patients.			Age of the patients.			
	1–15.	15–40.	45.	1–15.	15–40.	45.	Total.
Multiple Tubercular Foci.							
Healed . .	1	1	1	2	7	—	12
Improved .	—	—	—	1	1	1	3
Stationary .	—	—	—	—	—	—	—
Died . . .	—	—	—	—	—	—	—
Tuberculosis of Ribs.							
Heated . .	1	9	1	3	3	3	20
Improved .	—	2	—	1	3	3	9
Stationary .	—	—	—	—	1	—	1
Died . . .	—	—	—	—	1	1	2
Tuberculosis of Sternum.							
Healed . .	1	7	2	—	—	2	12
Improved .	—	—	—	—	3	1	4
Stationary .	—	—	—	—	—	—	—
Died . . .	—	—	—	—	—	—	—
Tuberculosis of Limbs.							
Healed . .	3	4	—	—	6	1	14
Improved .	—	—	1	—	—	—	1
Stationary .	—	—	—	—	—	1	1
Died . . .	—	—	—	—	—	—	—
Tuberculosis of Cranium.							
Healed . .	1	—	—	—	—	1	2
Improved .	—	—	—	—	—	—	—
Stationary .	—	—	—	—	—	—	—
Died . . .	—	—	—	—	—	—	—
Total . .							81

Duration of Treatment (in months).

	Multiple.	Ribs.	Sternum.	Limbs.	Cranium.
Average	19	9	10·5	12·25	13
Maximum . . .	37	22	17	28	23
Minimum	7	2	3	5·5	3

Note.—11 out of 81 cases showed also other foci. The cause of death was meningitis in one case and miliary tuberculosis in another.

PERITONITIS : 194 cases.

I. *Total Results.*

	Healed.	Improved.	Stationary.	Died.
Total percentage (194 cases) .	50·92% 108	23·14% 45	7·21% 14	8·73% 17

II. *Individual Results.*

(*a*) Closed Peritonitis.

Age.	Fibrous-adhesive form.				Ascitic form.				Dry form.				Total.
	Hld.	Imp.	Stat.	Died.	Hld.	Imp.	Stat.	Died.	Hld.	Imp.	Stat.	Died.	
1–15	13	—	—	—	12	1	1	1	4	1	—	—	33
15–40	50	20	6	10	10	5	3	5	11	2	1	—	123
Over 40	3	4	1	1	1	—	—	—	—	—	—	—	10

(*b*) Open Peritonitis.

1–15	2	—	—	—	—	—	—	—	—	—	—	—	2
15–40	9	5	2	—	—	2	—	—	1	2	—	—	21
Over 40	2	2	—	—	—	—	—	—	—	1	—	—	5
Total .	79	31	9	11	23	8	4	6	16	6	1	—	194

Duration of Treatment (in months).

Average	9·5	12	7
Maximum	36	36	19
Minimum	2	5	2

Note.—29 cases out of 194 were complicated by pulmonary tubercle, 12 had fæcal fistulæ, 8 intestinal tubercle, 6 visceral or bone tubercle.

The cause of death was :

Meningitis	2 cases
Miliary tuberculosis	4 ,,
Ulceration of bowels with internal hæmorrhage . .	4 ,,
Advanced pulmonary tuberculosis	5 ,,
Cerebral hæmorrhage (due to syphilis)	1 case
Suicide	1 ,,

TUBERCULOSIS OF INTESTINE : 34 cases.

I. *Total Results.*

	Healed.	Improved.	Stationary.	Died.	Total.
Total percentage . . .	11·76% 4	44·12% 15	41·08% 14	2·9% 1	34

II. *Individual Results.*

Age of the patients.	Healed.	Improved.	Stationary.	Died.	Total.
1–15 years	—	2	2	—	4
15–40 „	4	9	10	1	24
Over 40 „	—	4	2	—	6
Total	4	15	14	1	34

Duration of Treatment (in months).

Average : 21. Minimum : 17. Maximum : 23.

Note.—Death was due to amyloid degeneration.

ANAL FISTULA : 9 cases.

Age of the patients.	Healed.	Improved.	Stationary.	Died.	Total.
1–15 years	—	—	—	—	—
15–40 „	2	3	2	—	7
Over 40 „	1	1	—	—	2
Total	3	4	2	—	9

Duration of Treatment (in months).

Average : 8. Minimum : 4. Maximum : 16.

TUBERCULAR ADENITIS : 366 cases.

I. *Total Results.*

	Healed.	Improved.	Stationary.	Died.	Total.
Total percentage . . .	78·15% 286	17·76% 65	2·73% 10	1·36% 5	366

II. *Individual Results.*

(*a*) Closed: 278 cases. (*b*) Open: 79 cases.

	Age of the patients.			Age of the patients.			Total.
	1–15.	15–40.	40.	1–15.	15–40.	40.	
Cervical, Supra-clavicular and Submaxillary Glands.							
Healed . .	36	39	4	22	23	2	126
Improved .	3	11	1	3	6	1	25
Stationary .	1	3	1	—	—	—	5
Died . . .	1	—	—	—	—	—	1
Tracheo-bronchial Glands.							
Healed . .	88	16	2	—	—	—	106
Improved .	9	11	—	—	—	—	20
Stationary .	—	—	—	—	—	—	—
Died . . .	—	—	—	—	—	—	—
Mesenteric Glands.							
Healed . .	13	8	—	—	—	—	21
Improved .	—	1	—	—	—	—	1
Stationary .	—	2	—	—	—	—	2
Died . . .	—	—	—	—	—	—	—
Axillary Glands.							
Healed . .	—	1	—	—	2	—	3
Improved .	—	—	1	—	—	—	1
Stationary .	—	—	—	—	—	—	—
Died . . .	—	—	—	—	—	—	—
Inguinal Glands.							
Healed . .	—	1	—	—	—	—	1
Improved .	—	1	—	—	—	1	2
Stationary .	—	—	—	—	—	—	—
Died . . .	—	—	—	—	—	—	—
General Tuberculous Adenitis.							
Healed . .	10	10	—	4	5	—	29
Improved .	4	5	2	2	3	—	16
Stationary .	—	2	—	—	1	—	3
Died . . .	1	—	—	—	1	2	4
Total . .							366

Duration of Treatment (in months).

	Cervical, supra-clavicular and sub-maxillary glands.	Tracheo-bronchial glands.	Mesenteric glands.	Axillary glands.	Inguinal glands.	General adenitis.
Average . .	5·6	8	10	9	4	8
Maximum . .	25	24	26	13	8	12
Minimum . .	1	2	3	3	2	2

Note.—65 of the 366 cases exhibited also other lesions, namely: 35 pulmonary tubercle, 8 pleurisy, 3 peritonitis, etc.

Cause of death was:

Miliary tuberculosis	1 case
Advanced pulmonary tuberculosis	1 „
Meningitis	1 „
Cardiac trouble	1 „

GENITO-URINARY TUBERCULOSIS: 188 cases.

I. *Total Results.*

	Healed.	Improved.	Stationary.	Died.	Total.
Total percentage	46·81% 88	34·58% 65	7·44% 14	11·17% 21	188

II. *Individual Results.*

(*a*) Closed. (*b*) Closed.

	Age of the patients.			Age of the patients.			Total.
	1–15.	15–40.	40.	1–15.	15–40.	40.	
Unilateral Renal Tuberculosis.							
Healed	1	27	1	1	9	1	40
Improved	2	27	3	—	4	—	36
Stationary	—	5	—	—	2	—	7
Died	—	6	2	—	1	—	9
Bilateral Renal Tuberculosis.							
Healed	—	5	—	—	—	—	5
Improved	—	8	—	—	—	—	8
Stationary	1	—	—	—	—	—	1
Died	—	5	1	—	1	—	7
Tuberculosis of Bladder following Nephrectomy.							
Healed	1	2	1	—	—	—	4
Improved	—	1	—	—	—	—	1
Stationary	—	1	—	—	—	—	1
Died	—	—	—	—	—	—	—
Epididymitis.							
Healed	2	14	2	—	9	1	28
Improved	—	9	4	—	3	—	16
Stationary	—	—	2	—	2	1	5
Died	—	2	—	—	2	—	4
Tuberculosis of Appendages.							
Healed	1	10	—	—	—	—	11
Improved	—	3	—	—	1	—	4
Stationary	—	—	—	—	—	—	—
Died	—	1	—	—	—	—	1
Total							188

Duration of Treatment (in months).

	Unilateral kidney trouble.	Bilateral kidney trouble.	Bladder trouble following nephrectomy.	Epididymitis.	Pelvic adnexitis.
Average	15	28	3·5	14	13
Maximum . . .	33	84	5	45	43
Minimum	2	3	2	5	4

Note.—67 of the 188 cases showed other lesions as well, namely: 13 pulmonary tubercle, 5 epididymitis, and 21 severe bladder trouble.

Cause of death was:

Uræmia	4 cases
Miliary tuberculosis	4 ,,
Pulmonary tuberculosis	4 ,,
Renal hæmorrhage	2 ,,
Icterus	2 ,,
Intestinal tuberculosis	2 ,,
Meningitis	2 ,,
Cardiac trouble	1 case

Of the 45 healed cases 24 were operated upon. The cure was confirmed by examination of the remaining kidney and bladder.

Of the 44 improved cases 34 left Leysin in order to undergo nephrectomy, after one kidney and bladder had been cured.

Of 113 cases of renal tuberculosis 58 had nephrectomy done.

Lupus.

Age of the patients.	Healed.	Improved.	Stationary.	Died.	Total.
1–15 years . . .	2	—	—	—	2
15–40 ,, . . .	5	4	—	—	9
Over 40 ,, . . .	3	1	1	—	5
Total . . .	10	5	1	—	16
Total percentage of results	62·5%	31·25%	6·25%	—	—
	10	5	1	—	16

Duration of Treatment (in months).

Average: 16. Minimum: 6. Maximum: 38.

Poncet's Rheumatism.

Age of the patients.	Healed.	Improved.	Stationary.	Died.	Total.
1–15 years . . .	—	—	—	—	—
15–40 ,, . . .	4	11	2	1	18
Over 40 ,, . . .	1	—	—	—	1
Total . . .	5	11	2	1	19
Total percentage of results	26·31%	57·89%	10·53%	5·27%	—
	5	11	2	1	19

Duration of Treatment (in months).

Average: 24. Minimum: 4. Maximum: 65.

Empyema.

Age of the patients.	Healed.	Improved.	Stationary.	Died.	Total.
1–15 years . . .	—	1	—	—	1
15–40 „ . . .	1	2	2	1	6
Over 40 „ . . .	—	—	—	—	—
Total . . .	1	3	2	1	7
Total percentage of results	14·28%	42·85%	28·58%	14·28%	—
	1	3	2	1	7

Average duration of treatment : 12.

Note.—Cause of death : pulmonary tubercle.

The statistics 1914-21 as compared with 1903–13 show a relatively large number of " Improved " cases; this is due to the fact that a great number of patients were obliged to interrupt their treatment owing to the Great War. Equally, for economic reasons, during the war patients were admitted with much more severe local lesions and in considerably worse general condition.

STATISTICS OF PATIENTS SUFFERING FROM SURGICAL TUBERCULOSIS TREATED BETWEEN 1903 AND 1913.

TOTAL NUMBER OF PATIENTS { CHILDREN 652 / ADULTS 477 } 1129.

	Total.	Healed.	Improved.	Stationary.	Died.	Remarks.
CLOSED TUBERCULOSIS . .	804	703	73	22	6	
WITH SEPTIC INFECTION . .	325	242	39	19	25	
Total	1129	945	112	41	31	
Spinal caries :						[a] Arrived with complete paraplegia and cystitis. [b] Advanced pulmonary tuberculosis. [c] Arrived *in extremis*. [d] Amyloid degeneration.
Without abscess . . .	102	90	10	1	1[a]	
With abscess	68	64	2	1	1[b]	
With sinuses	28	17	6	3	2[cd]	
Total	198	171	18	5	4	
Tuberculosis of the pelvic bones (and sacro-iliac disease) :						[a] Arrived with amyloid degeneration.
Without abscess . . .	6	6	—	—	—	
With abscess	10	10	—	—	—	
With sinuses	21	9	1	6	5[a]	
Total	37	25	1	6	5	

	Total.	Healed.	Improved.	Stationary.	Died.	Remarks.
Tuberculosis of hip :						[a] Of which 102 recovered mobility in the joint. [b] 4 arrived with amyloid degeneration, 2 pulmonary, 1 meningitis.
Without abscess . . .	83	76	7	—	—	
With abscess	36	29	5	2	—	
With sinuses	39	20	9	3	7[b]	
Total	158	125[a]	21	5	7	
Tuberculosis of knee :						[a] 78 recovered mobility in the joint. [b] Amyloid degeneration and pulmonary.
Without abscess . . .	94	85	7	2	—	
	14	12	2	—	—	
	12	9	1	1	1[b]	
Total	120	106[a]	10	3	1	
Tuberculosis of foot :						[a] Cerebral abscess following alveolar periostitis.
Without abscess . . .	35	33	2	—	—	
With abscess	17	15	—	1	1[a]	
With sinuses	42	39	2	1	—	
Total	94	87	4	2	1	
Tuberculosis of shoulder :						[a] 4 recovered mobility in the joint.
Without abscess . . .	3	3	—	—	—	
With abscess	4	3	1	—	—	
With sinuses	5	3	2	—	—	
Total	12	9[a]	3	—	—	
Tuberculosis of elbow :						[a] Of which 20 recovered mobility in the joint.
Without abscess . . .	9	8	1	—	—	
With abscess	6	6	—	—	—	
With sinuses	15	14	1	—	—	
Total	30	28[a]	2	—	—	
Tuberculosis of hand :						[a] Pulmonary and meningitis. [b] Pulmonary and multiple tuberculosis. [c] All recovered articular function.
Without abscess . . .	8	7	—	—	1[a]	
With abscess	5	5	—	—	—	
With sinuses	8	5	1	1	1[b]	
Total	21	17[c]	1	1	2	
Tuberculous dactylitis :						
Without abscess . . .	12	12	—	—	—	
With abscess	3	3	—	—	—	
With sinuses	17	16	1	—	—	
Total	32	31	1	—	—	
Tuberculous ostitis :						[a] Multiple tuberculosis and amyloid degeneration.
Closed	36	32	4	—	—	
With sinuses	49	41	4	2	2[a]	
Total	85	73	8	2	2	

	Total.	Healed.	Improved.	Stationary.	Died.	Remarks.
Tubercular peritonitis :						[a] 3 with tuberculous ulceration of intestine, 1 meningitis, 1 amyloid degeneration.
Closed	57	49	4	3	1	
With fistulæ	29	20	3	2	4	
Total	86	69	7	5	5[a]	
Tuberculosis of kidney	31	12	13	6	—	[a] Cachexia and amyloid degeneration on arrival.
Sinuses following nephrectomy	20	15	4	—	1[a]	
Total	51	27	17	6	1	
Tuberculous epididymitis	9	7	2	—	—	
Ileo-cæcal tuberculosis	16	10	4	—	2[a]	[a] Complicated with severe tuberculous ulceration of intestine.
Tuberculosis of uterine adnexa	6	5	1	—	—	
Tuberculous glands (including tracheo-bronchial)	75	64	4	6	1[a]	[a] Pulmonary tuberculosis.
With abscess	23	23	—	—	—	
With sinuses	38	35	3	—	—	
Total	136	122	7	6	1	
Polyarthritis and tuberculous rheumatism (Poncet)	10	9	1	—	—	
Tuberculosis of the eye	9	8	1	—	—	
Of the ears	3	3	—	—	—	
Scrofulodermia, tuberculides and lupus	16	13	3	—	—	

STATISTICS OF PATIENTS SUFFERING FROM SURGICAL TUBERCULOSIS TREATED DURING THE PERIOD 1913-1921.

By "healed" we mean that the disease is shown to be arrested both clinically and radiographically and that no relapse has taken place so far as we are aware.

	Total.	Healed.	Improved.	Stationary.	Died.	Remarks.
Spinal caries :						[a] 4 meningitis, 5 pulmonary, 1 Addison's disease, 2 influenza.
Without sinuses . . .	274	205	47	10	12[a]	
With sinuses	96	30	31	16	19	
Total	370	235	78	26	31	
Tuberculosis of pelvic bones (sacro-iliac disease) . . .	24	20	3	—	1[a]	[a] Renal tuberculosis.
With sinuses	22	12	8	2	—	
Total	46	32	11	2	1	
Tuberculosis of the hip joint .	130	92[b]	27	6	5[a]	[a] 1 miliary, 1 pulmonary, 1 amyloid, 1 pneumonia, 1 purulent pleurisy. [b] Return of function in 48 cases.
Tuberculosis of the knee . .	192	138[c]	47	5	2[a]	[a] 1 meningitis, 1 pulmonary. [b] 1 amyloid, 1 meningitis, 1 pulmonary. [c] Return of function in 86 cases.
With sinuses	40	28	9	—	3[b]	
Total	232	166	56	5	5	
Tuberculosis of foot . . .	128	105	18	2	3[a]	[a] 1 pulmonary, 2 meningitis.
Tuberculosis of shoulder . .	33	28[a]	5	—	—	[a] Return of function in 18 cases.
Tuberculosis of elbow . . .	31	22[a]	7	2	—	[a] Return of function in 17 cases.
Tuberculosis of hand and wrist	77	42[b]	31	1	3[a]	[a] 2 miliary, 1 meningitis. [b] All with return of function, partial or complete.
Tuberculous ostitis . . .	35	32	3	—	—	[a] 1 meningitis, 1 miliary.
With sinuses	46	28	14	2	2[a]	
Total	81	60	17	2	2	

	Total.	Healed.	Improved.	Stationary.	Died.	Remarks.
Tuberculous peritonitis . .	166	104	33	12	17	[a] 5 pulmonary, 4 miliary, 4 ulcerative enteritis, 2 meningitis, 1 cerebral hæmorrhage, 1 suicide.
With fistulæ	28	14	12	2	—	
Total	194	118	45	14	17[a]	
Urogenital tuberculosis :						[a] 4 uræmia, 4 miliary, 4 pulmonary, 2 renal hæmorrhage, 2 apoplexy, 2 meningitis, 2 intestinal tuberculosis, 1 cardiac failure.
Tuberculosis of one kidney .	74	29	32	5	8	
With sinuses	18	11	4	2	1	
Both kidneys	21	5	8	1	7	
Tuberculosis of bladder . .	6	4	1	1	—	
Tuberculous epididymitis . .	37	18	13	4	2	
With sinuses	16	10	3	1	2	
Tuberculosis of uterine adnexa	15	11	4	—	1	
Total	187	88	65	14	21[a]	
Tuberculosis of intestines . .	34	4	15	14	1[a]	[a] Amyloid degeneration.
Anal fistula	9	3	4	2	—	
Tuberculous ostitis and periostitis :						[a] 1 meningitis, 1 miliary.
Closed	35	32	3	—	—	
Open	46	28	14	2	2[a]	
Total	81	60	17	2	2	
Tuberculous adenitis :						[a] 1 miliary, 1 pulmonary, 1 meningitis, 1 cardiac failure, 1 uræmia.
Closed	228	228	49	9	2	
Open	78	58	16	1	3	
Total	306	286	65	10	5[a]	
Lupus	16	10	5	1	—	
Tuberculous rheumatism . .	19	5	11	2	1[a]	[a] Meningitis.

VIII. RADIOLOGICAL CONTROL OF THE RESULTS

(By H. I. Schmid, M.D.)

In a clinic where tuberculosis of bones and joints is treated, the radiologist occupies a very responsible position. He is not only expected to give information concerning the seat of disease and its relationship with neighbouring structures; he is also expected to give his opinion on the prognosis of each individual case, and on the correction obtained or still to be attempted; he is looked to for an explanation of clinical symptoms and, lastly, this expert has to give his verdict on the final and delicate question, a question of conscience, namely, the question of recovery.

The first thing that an *X*-ray picture ought to supply, namely, an exact diagnosis, requires a careful differential consideration, which, although often easy, may yet be sometimes very difficult. All cases that have been labelled tuberculous are not so in reality by a long way. Let me remind the reader of the so-called osteo-chondritis deformans juvenilis, arthritis of acute, infectious, rheumatic type, infective spondylitis, chronic rigidity of spine, incipient tumours, congenital dislocation, malformations, etc. Small foci in bones and bone marrow may be overlooked on the plate, and the destruction which may become visible later on teaches us over and over again that we are only able to follow the details of pathological anatomy *en gros*. Despite this, however, the safest way lies in the close combination of both radiology and wide clinical experience.

The general facts which the radiology of surgical tuberculosis teaches us are the following :—

(1) Radiologically visible changes are not always equivalent to the clinical signs as regards their extent and gravity. There are discrepancies in both directions, but as a rule the positive signs shown by the skiagram are more pronounced than were expected.

(2) For making a differential diagnosis the *X*-ray picture is more serviceable than other clinical methods. Diagnosis can often be made at an early stage.

(3) The exact localization of the foci—which depends on the blood supply—gives prognostically valuable data and explains the individual peculiarities of different cases although belonging to the same category. Just as the patient's age and power of resistance are of importance clinically, so the varieties shown by the radiograms are an expression of pathologico-anatomical details. The unequal duration of infection in different persons may in this way be explained quite satisfactorily.

(4) Although clinical symptoms may have passed away, there may not yet be quiescence at the site of the lesion. There may be a certain activity there which may be only an expression of the reorganization and rebuilding of the bone tissue in the course of adaptation to the altered static and dynamic conditions.

A large number of notable writers (Köhler, Kienböck, Rumpel, Sudeck, Küttner, v. Friedländer, Ludloff, Albees-Schönberg, Fränkel, Oberst and others) have devoted themselves to the consideration of the diagnostic peculiarities of surgical tuberculosis as shown by the *X*-rays. But our knowledge in this respect has been made possible by the preparatory work of pathologists (Heile, Schmidt, etc.) and surgeons (Volkmann, König, Krause and others).

Tuberculosis of bones is characterised by the marked destructive behaviour of the granulating tissues. There is primary destruction with a slight and delayed periosteal reaction and a secondary reproduction on an infinitesimal scale.

The primary destruction is represented in skiagrams as follows :

(*a*) Initial acute excentric atrophy to a varying extent. The increased penetrability of light resulting herefrom is due to the loss of calcium salts. The appearance of this phenomenon may be taken to be an early symptom of articular tuberculosis and also of tropho-neurotic disturbances. In later stages of bone trouble it follows a perforation of a lesion into the joint.

(*b*) Structural changes : (1) Circumscribed clear areas,

single disseminated or else confluent dark spots, representing granulating masses along with condensation of the spongy tissue caused through local reaction; (2) sequestration, which is often invisible in rarefied bones but always distinct in the rare cases of sclerosis of the articular bone ends; (3) disappearance of the structural pattern with the exception of a thin cortical membrane.

(*c*) Rarefaction, which alters the exterior shape of the bones (cortical defects) and leads to alteration of the mutual relationship between the healthy and the diseased bone; caries; fractures.

Amongst the secondary reproductive processes are to be mentioned:

(*a*) Periosteal reaction proper. This is absent in cases of pure epiphyseal lesions. Metaphyseal foci—most common of all—display a typically sluggish and insignificant apposition of periosteal products. Tuberculosis of the bone shafts, however, calls forth periosteal changes similar to dactylitis. Most striking in all these localizations is the difference between tuberculosis and acute or chronic osteo-myelitis, the latter being characterised by powerful new bone formation and the ever-present sclerosis of the peri-focal bone tissue.

(*b*) Pathological increase of bone nuclei and growth of the epiphyses may often be observed, the result of such processes being an elongation of the affected bone.

All the signs mentioned so far apply solely to the influence of the virus on the bones and the joints. For the sake of completeness, however, we must also mention the changes involving the soft parts: abscesses, swelling of the articular capsule and of the bursæ, as well as true muscular atrophy.

Periosteal reaction is a reaction of the body to infection, and is to be regarded as a healing process in a wider sense. Recovery may, however, set in at any stage, and not all of the above-mentioned diagnostic signs need, therefore, become manifest; some stages may either be skipped or they may appear simultaneously, according to a quicker or slower evolution of the trouble, so that often no definite reaction of the periosteum takes place. This proves that the beginning of the recovery, its progress, and its conclusion are but loosely connected with a proper repairing periostitis.

FIG. 183.—Cervical spondylitis, on admission. Kyphosis resulting from lateral displacement of the 3rd cervical vertebra with partial destruction.

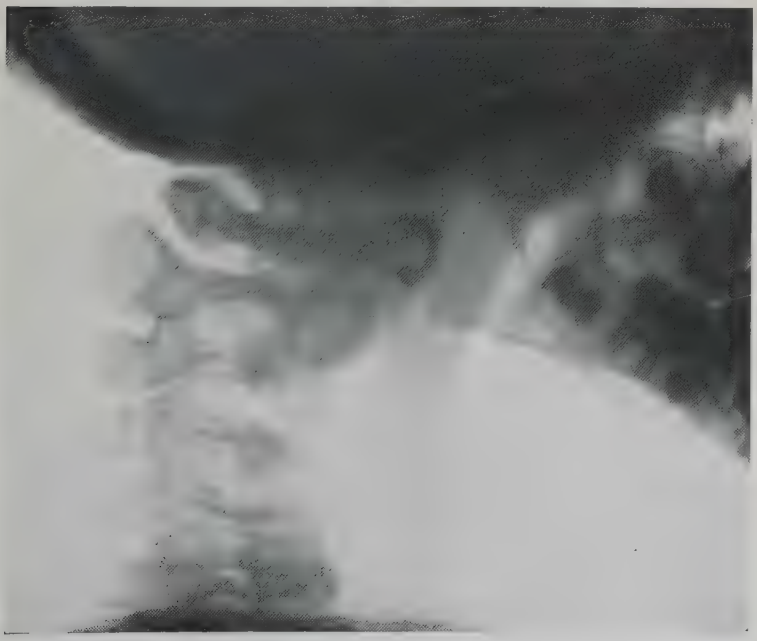


FIG. 184.—After recovery. 3rd vertebra returned to its proper position.

The healing processes in bone and joint tuberculosis exhibit the following stages in the order of their appearance :

(1) Sharp delimitation and demarcation of the healthy tissues ; marginal sclerosis of the defects.

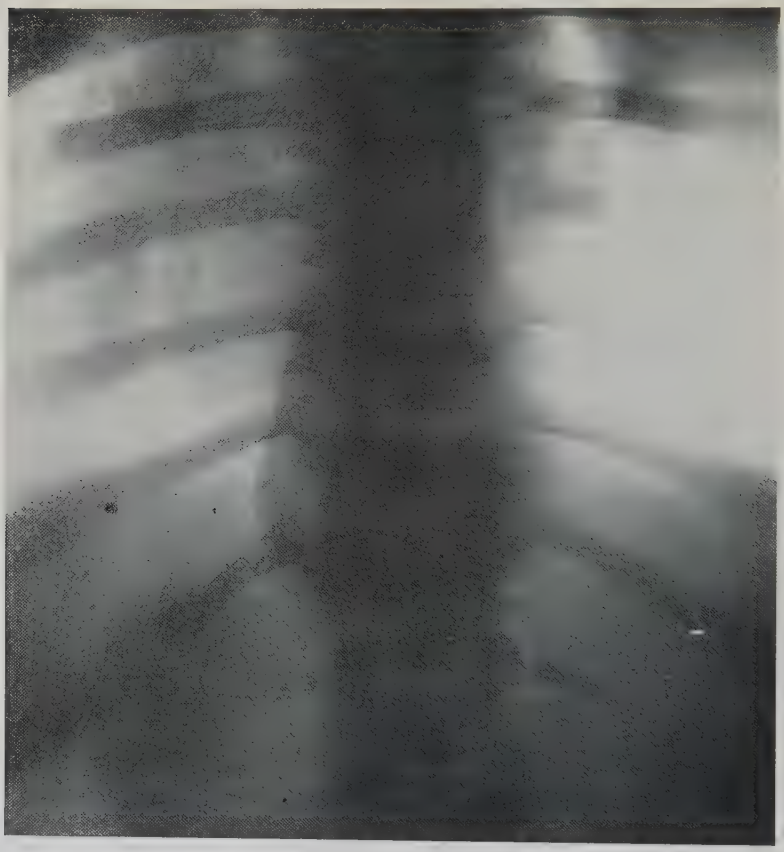


Fig. 185.—Girl of 8 ; caries of thoracic spine (10–11) ; active stage with abscess.

(2) Absorption of morbid products (fungating masses ; abscesses) and of periosteal (functionally non-essential) appositions.

(3) Functional re-adaptation : (*a*) of structure, that is, remodelling of structure into its static equivalent, but of a coarsely rarefied variety ; (*b*) of the bone as a whole ; formation of blocks, ankylosis, new joints and alteration of existing joints.

(4) Minor reproductive processes, formation of bridges, reorganization of small sequestra; refilling of small cavities with trabeculæ.

This roughly compiled list must not be taken to imply that each case of tuberculosis is bound to pass through all the

Fig. 186.—Recovery after spontaneous absorption of abscesses.

degrees mentioned here before it can be considered cured; this list is to be regarded rather as a joint result of numerous observations. Moreover, the individual points are not at all of the same importance. Though it should be emphasised that peripheral sclerosis, the barrier-like closure of the primary defect against the original focal area, may be considered to be a certain and constant sign of recovery. Of much importance

also is the trabecular, coarsely rarefied structure, which is always present in all really cured cases, whenever the trouble had affected a joint.

Healing of tubercular bones and joints is fortunately not a rare occurrence. Our *X*-ray reports prove that this takes

Fig. 187.—Lumbar caries (1–2 vert.) with abscess.

place very readily in cases free from mixed infection; though even in the complicated variety of cases this is not at all infrequent. The results obtained are lasting, and from the point of view of the final effect they are almost ideal, because they rarely involve the complete loss of functionally important bones and joints.

Radiographic records of cases treated surgically unfortunately show very frequently that the knife, even in the hands of a skilled surgeon, is too coarse an instrument to enable him to draw the line between the healthy or salvable tissues, and the

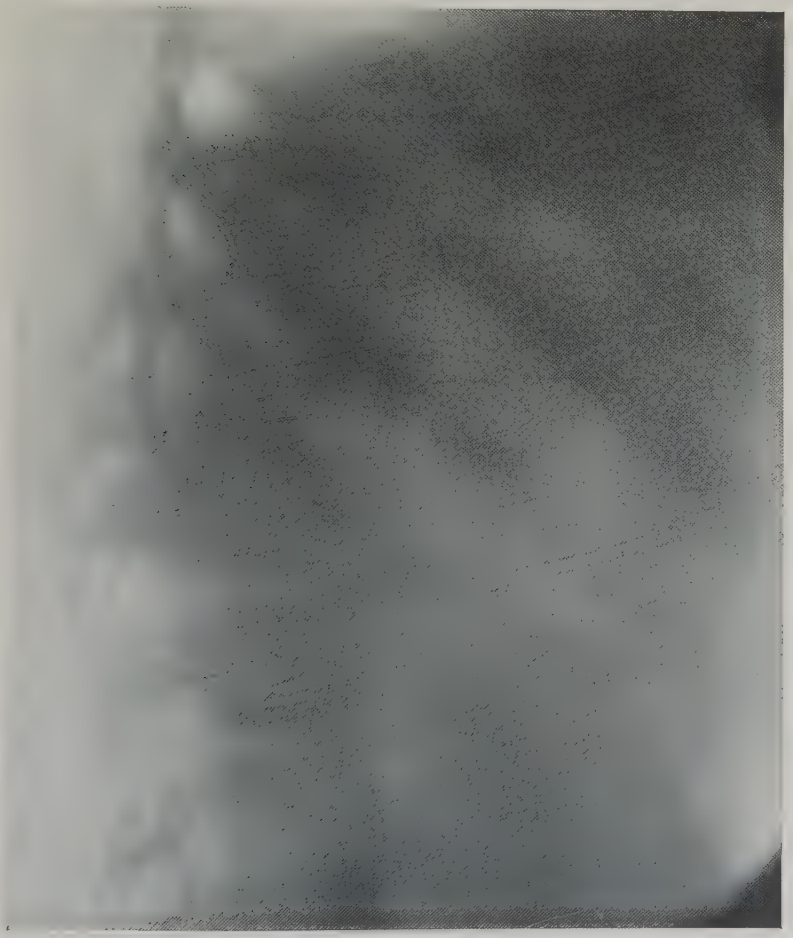


Fig. 188.—Lateral view of Fig. 187.

diseased or perished tissue. Many a bone has in the past been removed on the assumption that it was diseased, and only through the study of *X*-ray photographs have we been able to gain knowledge of bone atrophy and of the degree to which this

atrophy is capable of reparation. Thus we see that, on the whole, Nature is better able to find the correct line, and that she does so under proper conditions. It is true, though, that she does not go about it in a systematic manner, and, without

Fig. 189.—Lumbar caries (1–2). Same as Fig. 187. Recovery by block formation.

paying much heed to our conception of anatomy, she goes solely for the final object of functional and static adaptability. On the site of perishing joints we see useful nearthroses arise, and out of the remnants of extensively damaged bones firm supports are created in the shape of new blocks; or else a kind of

functional adaptation takes place which gradually transfers more and more work to a neighbouring intact joint.

Considerable are the individual peculiarities of different

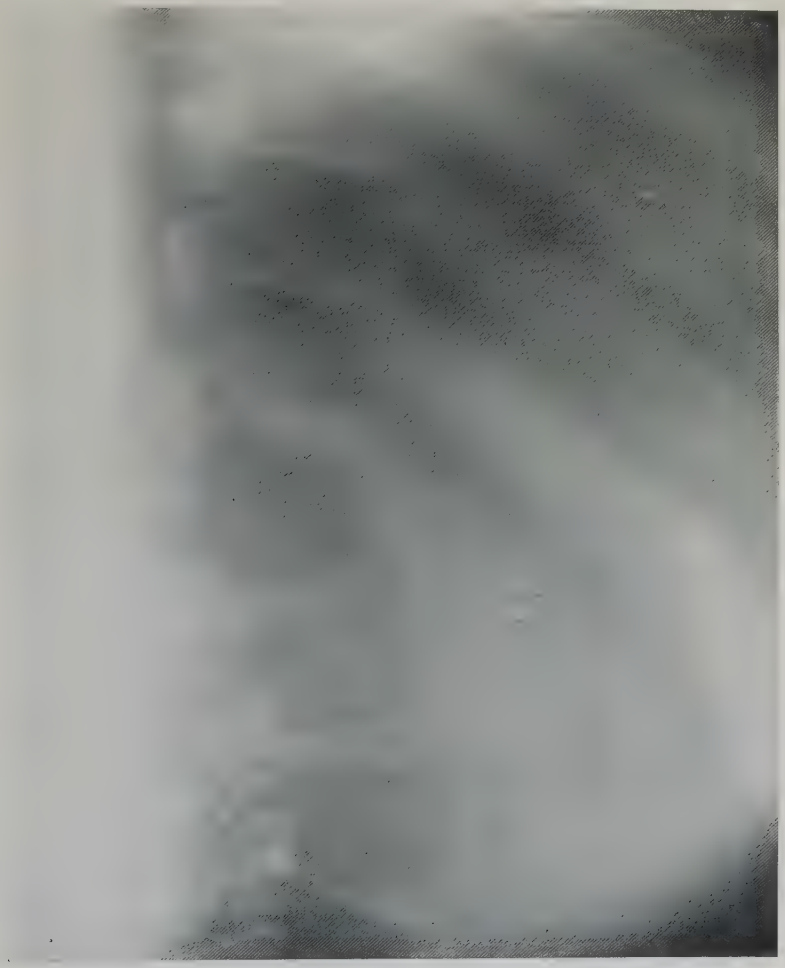


Fig. 190.—Lateral view of Fig. 189.

cases, though these may belong to one category. One is often inclined to believe in the presence of a kind of vital force which from the very commencement of the illness strives in a definite direction, and the circle of which we are but seldom able to

penetrate, owing to our ignorance of its extent. In this respect even the best of radiograms are unable to help us. Let us, for instance, take hip disease. It has often been observed that a focus in the epiphysis of the head of the femur and the roof of

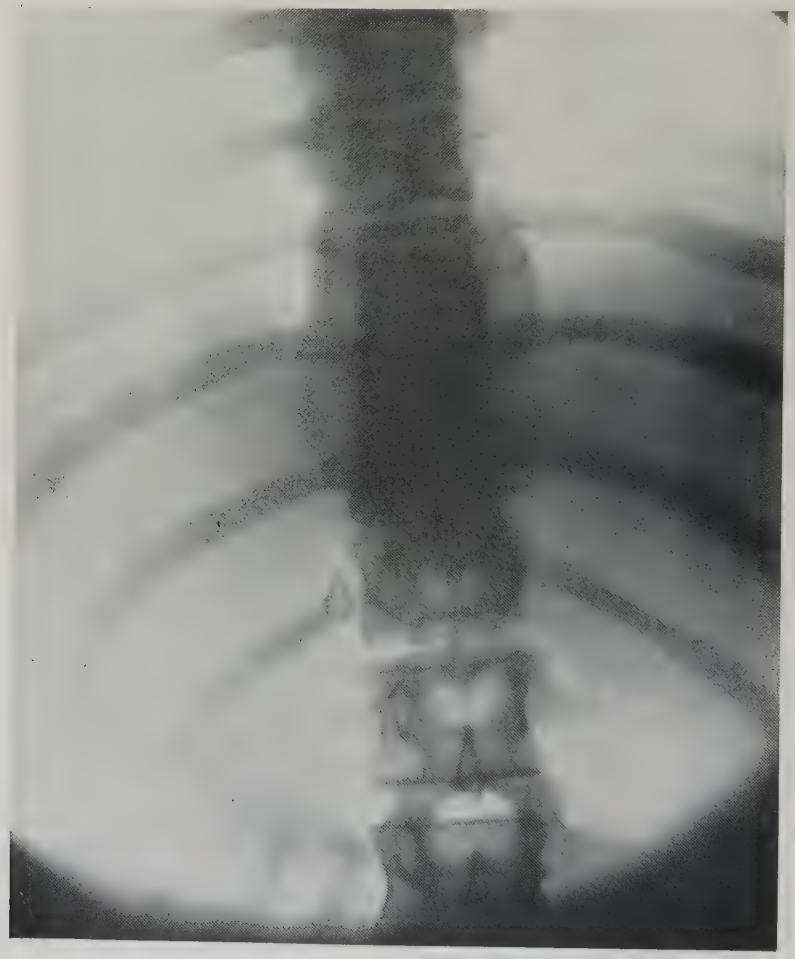


Fig. 191.—Dorsal caries (10—11 vert.) with peri-focal abscess.

the acetabulum may lead to extensive destruction of tissues and to marked displacement of the socket; or that a more central localization of the trouble in which the bottom of the acetabulum participates may end up by perforating into the

true pelvis; or that an apparently simple synovitis is merely a symptom of the rapidly spreading caries of the bone substance. All these complications may set in; but, on the other hand, even the most serious manifestation may at the very outset

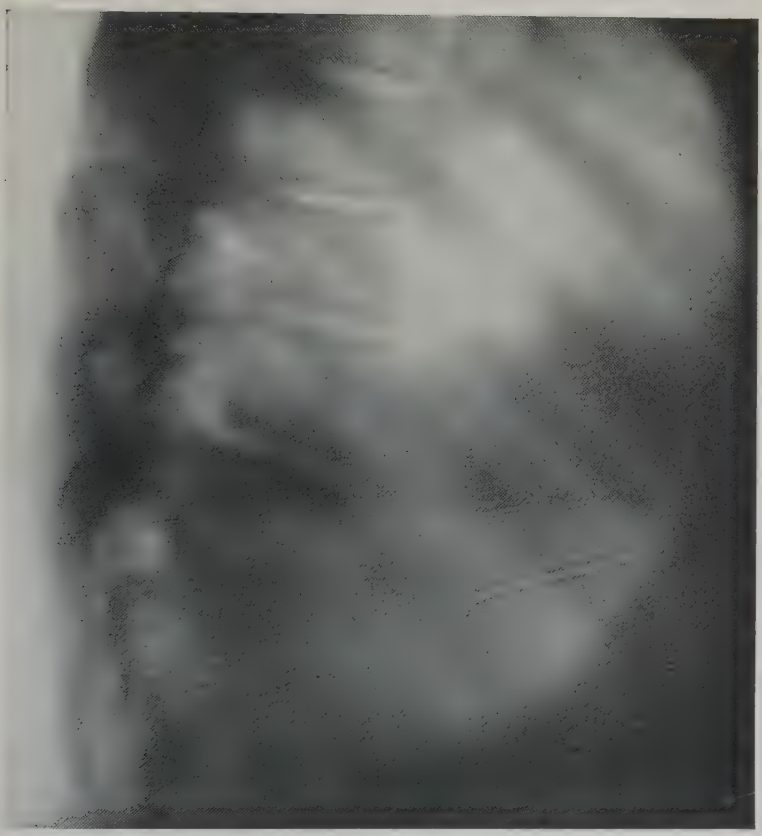


Fig. 192.—Lateral view of Fig. 191. Bodies of 10–11 vert. separated by a zone of destruction.

become arrested, and it may heal up without having ever reached the advanced stage.

Finally, let it be emphasised that only exact localization of the trouble can offer us some prognostic data with any degree of certainty. It allows us to forecast the probable course of events in advance, thus assisting the treatment in a consultative capacity.

The clinical differentiation between pure and mixed infected tuberculosis is also of interest to the radiographer. For as soon as a sinus has formed and has rendered infection possible — apart from the rare cases of hæmatogenous infection—the *X*-ray picture becomes altered too. The typical signs of pure bone tubercle as described above become markedly obscured. For instance, there is a change in the attitude of the periosteum, which reacts in a more distinct, defensive way; also the destructive processes gain momentum, so that the end-result will present itself much less favourably.

Heliotherapy, in the form it is practised here, makes recovery possible, and we can give this assurance to our patients or their parents; but how this will take place we can say precisely only after the study of the *X*-ray plates prepared in the course of the treatment.

A brief survey of the main localizations will enable us to appreciate better the peculiar character of the disease so far as its course and its treatment are concerned. The following observations are based entirely on our experience in Leysin.

Spinal Disease.—Cortical dissemination of sub-periosteal granulation foci, limited to the ventral portions of the spinal column, may have been present for a long time without showing on the plate. It is certain that these cases form but a small percentage of the "suspected" cases of spondylitis which come up for examination and which give negative radiological results. On the other hand, diffuse caseating internal ostitis must sooner or later show up in the picture, because the marked clinical syndrome of symptoms presupposes an escape of the trouble outwards. But it is in just these cases of spinal caries that the clinical signs and radiographic reports contradict each other. Both cardinal signs: caries of the vertebral bodies and abscess formation, deserve special attention.

Cured cases of spinal disease may display all kinds of changes in the vertebræ, from a small, well-defined defect to a consolidation of two or more vertebræ into one hard lump of bone. This formation of blocks is an ideal cure, because the newly-formed block acts like a wedge between the proximal and the distal portions of the column. The kyphosis that is thus necessarily produced is to a certain extent overcome by a compensatory

lordosis of the adjoining sections of the spine. Less satisfactory, because more unstable, is a cure without consolidation of bones, since a kind of pseudarthrosis of the intervertebral discs is likely to develop. The vertebral processes are too

Fig. 193.—Case Fig. 191, after recovery.

insignificant a support to be of much value in the process of recovery. The cases that came under my care after having undergone Albee's operation failed to convince me of the usefulness of bone grafts, holding together the spinous or lateral

processes, as a means of arresting caries or preventing the collapse of the primarily affected bodies of the vertebræ.

Cold abscesses which surround the lesion in a spindle-shaped

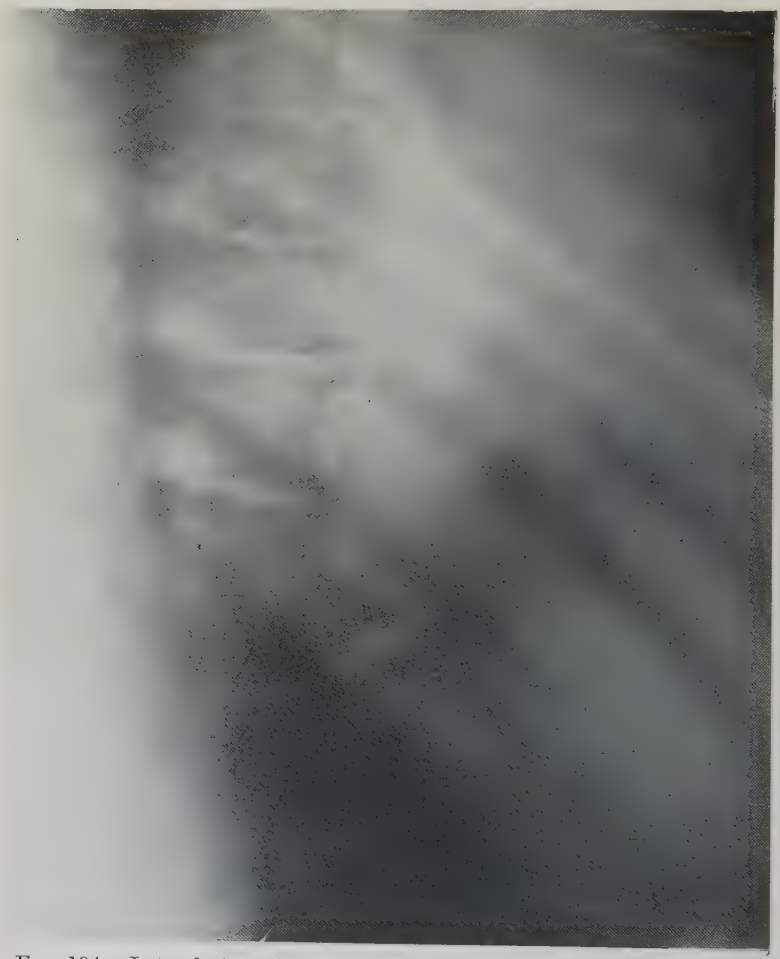


Fig. 194.—Lateral view of Fig. 191. The 10–11 vertebræ have formed a block.

fashion and which descend along the psoas muscle, but which may also ascend (if situated more deeply) along the thoracic spine, may disappear in one of two ways. One of them, commoner in children, is calcification; the remnants of the abscesses form either round, or kidney-shaped, thick shadows

around the site of the lesion and may remain stationary for years.

The other possibility is absorption of abscesses, which, how-

Fig. 195.—Boy of 6. Despite extensive resection very active hip disease involving iliac bone; profuse suppuration.

ever, is often slow and not uninterrupted, although the vertebral focus may have since ceased to be active.

Hip Disease.—Pure synovitis is on the whole rare, and when the affected joint is compared with the opposite healthy side, initial atrophy may always be easily recognised in the former.

The trabecular structure in the hip is best seen after the disappearance of inflammatory processes. Typical bone lesions—in the roof of the acetabulum, in the head or the neck of the femur or in the acetabulum itself—always affect the articular mechanism whenever they are related to the joint. The displacement of the socket often allows a new joint to be formed in preference to ankylosis. The iliac bone shows, as a rule, a sclerotic demarcation zone as a sign of pending recovery.

Fig. 196.—Cured with complete cicatrization and solid bony girders. Owing to resection function is much impeded and bending is present.

Perforation of the socket (with an ingrown head of the femur or shortened neck) may be recognised by the appearance of the "broken tear" picture described by Köhler; in many instances, however, a cure is effected by a bridge formed across the site of perforation and directed towards the true pelvis.

Epiphyseal foci of the head placed centrally should be regarded as particularly grave. Although encapsulation may take place, yet more often than not the epiphysis becomes utterly destroyed. This happens with an amazing rapidity in early childhood, involving considerable areas of the neck. The wedge-shaped

FIG. 197.—Boy of 12. Active coxitis; threatening perforation of acetabulum.

FIG. 198.—Cured; resulting structure is coarse; a solid osseous barrier has formed against the true pelvis.

FIG. 199.—Hip disease with perforation of the acetabulum and impaction of the femur.

Fig. 200.—Case Fig. 199 cured.

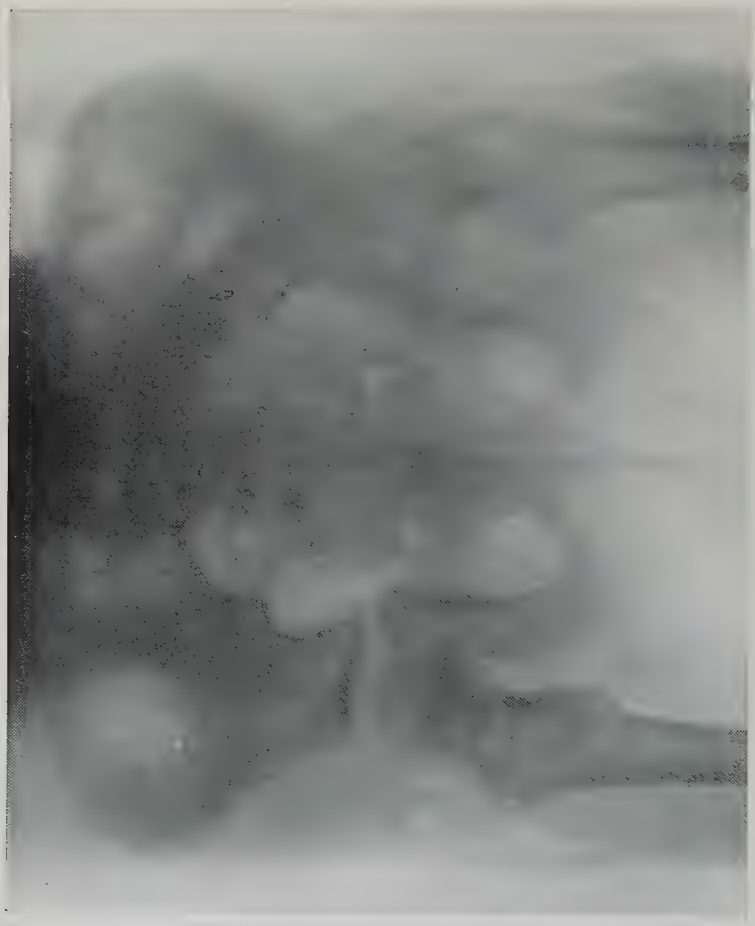


FIG. 201.—Patient of 8. Old active hip disease with complete destruction of the neck and the head of the femur. Marked atrophy. Ankylosis.

FIG. 202.—The contours of a misshapen head of the femur may be discerned amidst old débris. Considerable freedom of movement. Recovery after 2 years.

infarct-like epiphyseal focus leaves, however, certain portions of the head quite intact. The favourite seat is at the inner angle of the neck of the femur (metaphyseal localization), and it

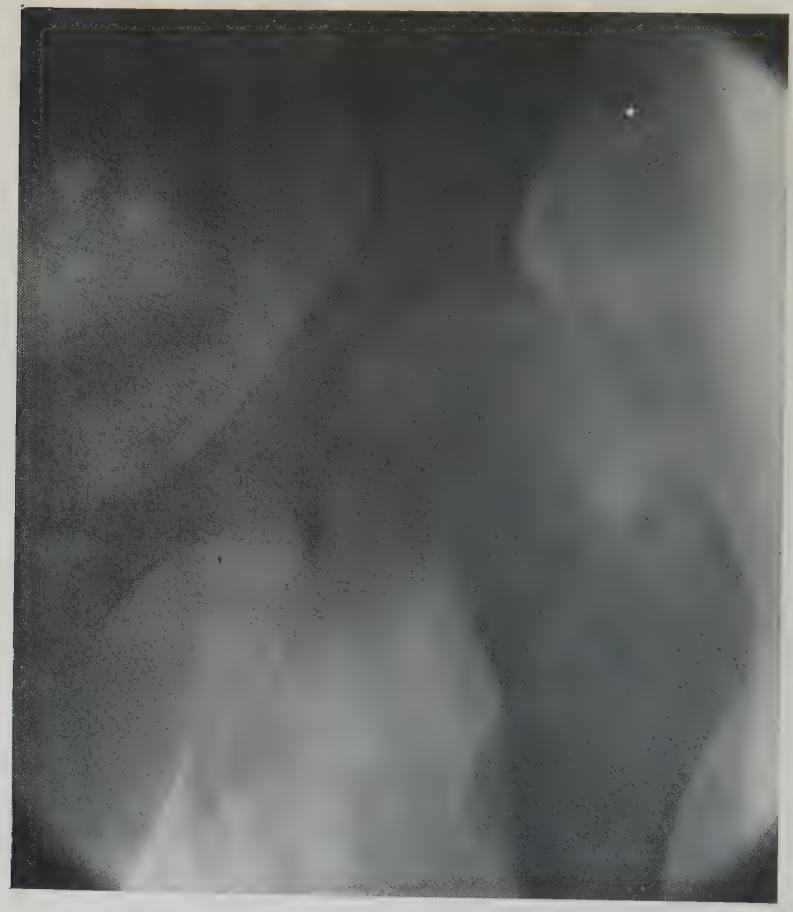


Fig. 203.—Caries of os ischii. Active stage.

usually spreads to the epiphysis itself; the trouble seldom chooses its way out along the more laborious extracapsular route.

It is evident that, with regard to localization and expansion, hip disease has a wide range of possibilities which can still be traced after a successful recovery. Each localization has its own radiographic history, and it would be quite impossible, therefore,

to speak here of a typical clinical course of the trouble or of typical results, seeing that each case has its own special individual cure. The commonest issue of coxitis is the establishment of a new joint, the functional adaptation of which is amazingly good. Ankylosis is rare in pure tuberculosis, but more frequent in mixed infection. In the really bad cases, however, it is always desirable to obtain even an imperfect cure.

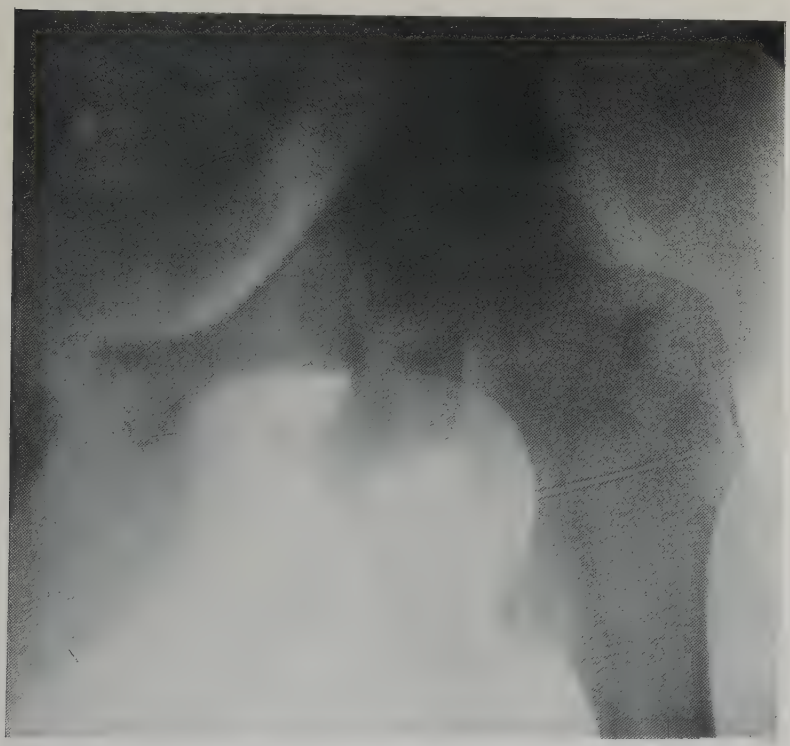


FIG. 204.—Same as Fig. 203 after elimination of a sequestrum. Recovery.

In *pelvic tuberculosis*, that is, tuberculosis of the sacro-iliac joint or ostitis of the os ischii, iliac or pubic bones, the healing process is exclusively demarcating. Nowhere—with the exception of the skull—do we find so little evidence of the process of repair. A good support for the body is all that should be aimed at, because a secondary functional adaptation is here impossible.

Synostosis between the iliac bone and the sacrum is a frequent occurrence after arthritis. Sequestra lying in the hiatus distalis of the sacro-iliac joint often show that it is quite possible for

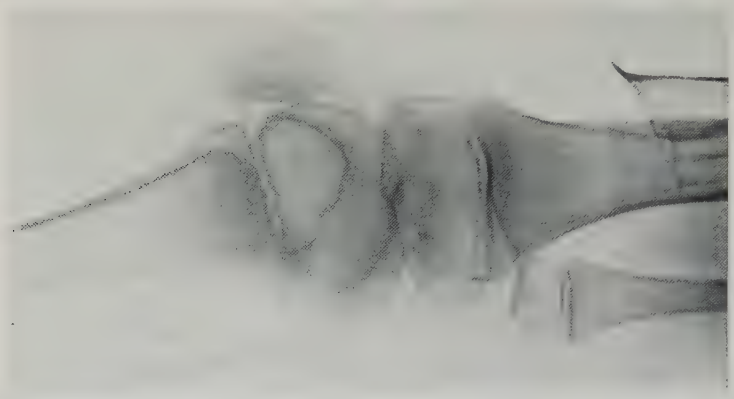


Fig. 206.—Same a year later. Cured.

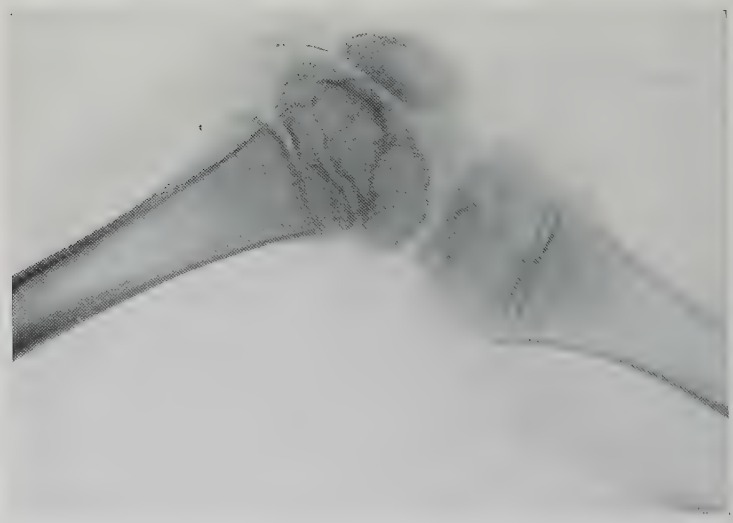


Fig. 205.—Boy of 11. Synovial gonitis with contracture.

them to become vascularised and reorganised, provided there was no mixed infection of the joint.

Knee-joint disease becomes manifest in the majority of cases only as synovitis. It is often impossible to say which subchondral foci are to be regarded as the primary seats of disease. The signs of wear and tear round the margins of the epiphyses

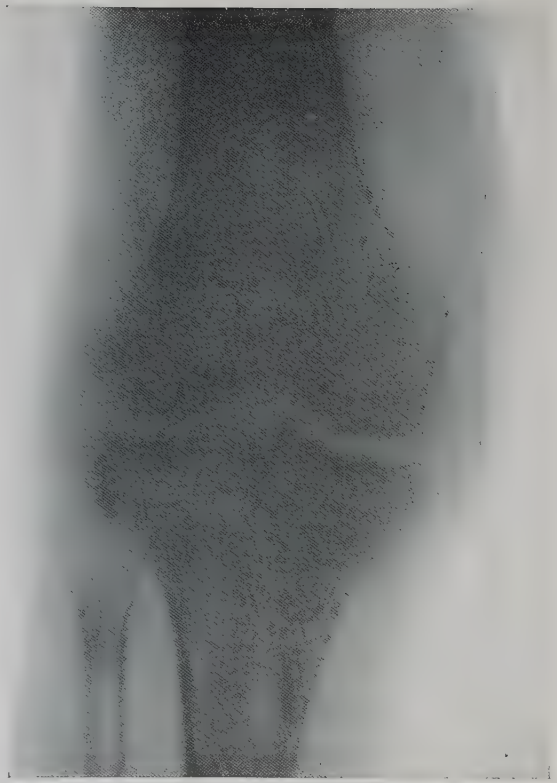


FIG. 207.—Active disease of the knee joint.

FIG. 208.—Same case as Fig. 207. Cured.

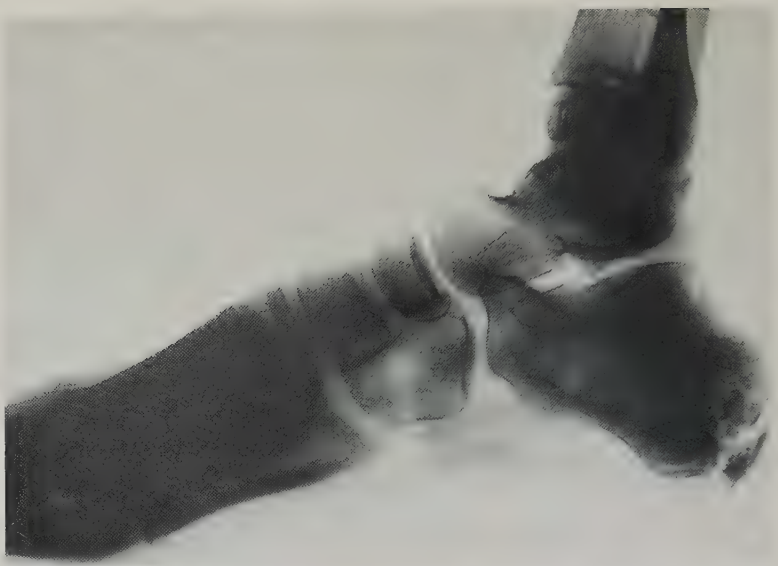


FIG. 209.—Girl of 14. Arthritis of the ankle joint with a focus in the post. process of os calcis with displacement of the apophysis.

FIG. 210.—8 months later: cured.

FIG. 211.—Arthritis of the ankle joint. Active stage.

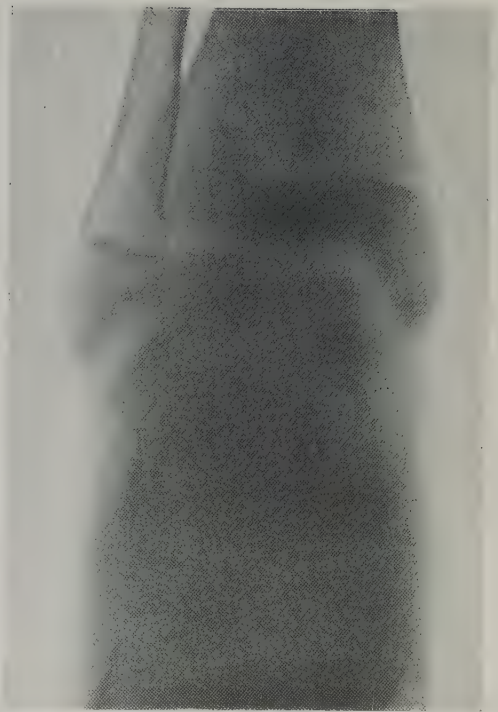


FIG. 212.—Same as Fig. 211 : antero-posterior view.

FIG. 213.—Recovery of case Fig. 211.

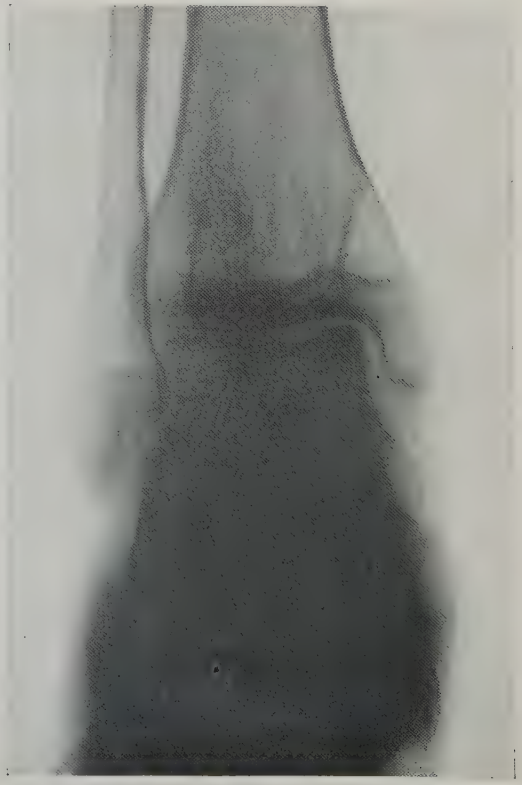


FIG. 214.—Antero-posterior view of Fig. 213.

which become noticeable in the course of treatment are, however, of secondary character. Infantile epiphysis lesions often recede without a hitch even if they happen to be intra-articular.

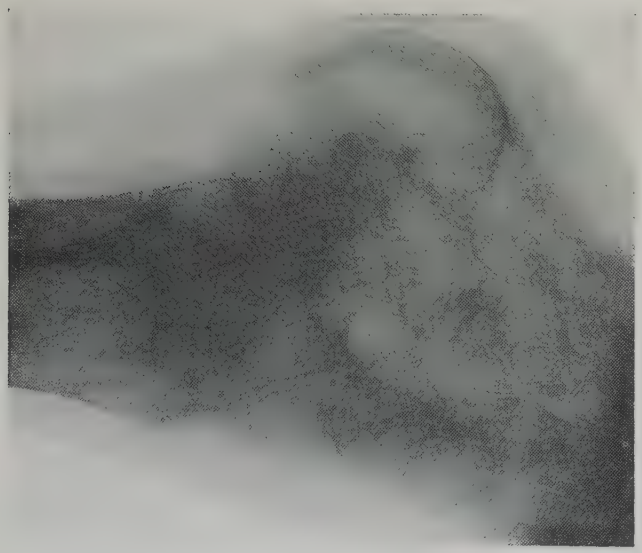


Fig. 216.
Bad case of ankle joint trouble with mixed infection.

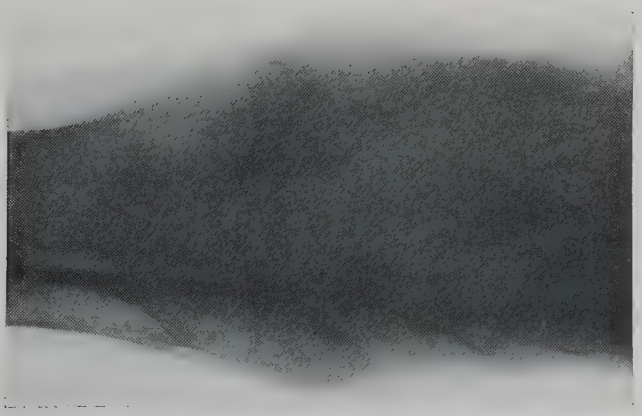


Fig. 215.

Generally speaking, the tendency to recovery is greater in bone lesions than in tubercular synovitis. In the latter form, the recovery, as determined by the *X*-rays, must be accompanied by rarefaction of bone structure, the primitive architecture of

FIG. 217.—Cure of case Fig. 215.

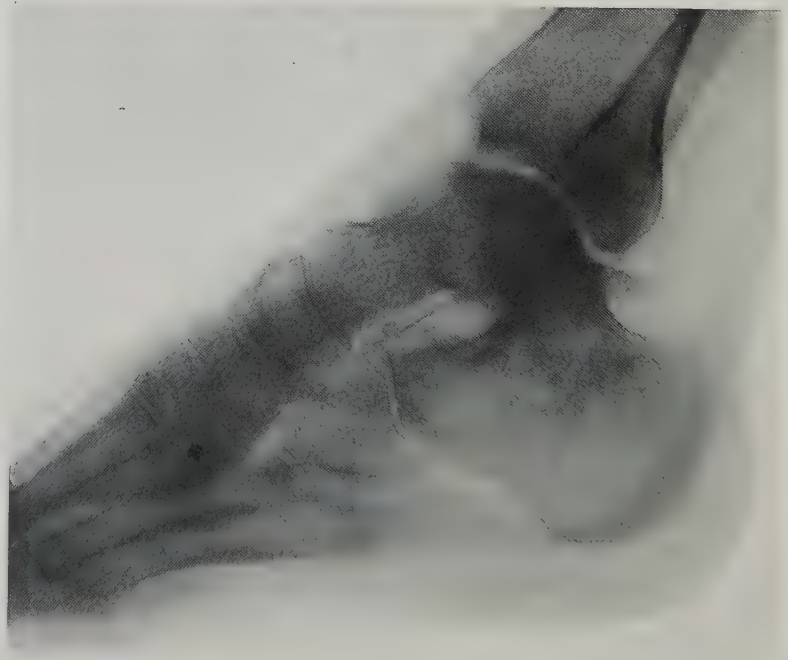


FIG. 218.—Lateral view of the same case.

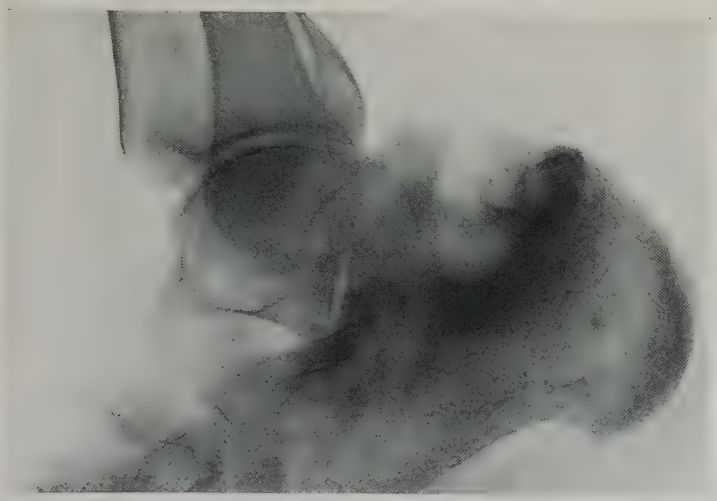


FIG. 219.—Male patient of 30. Tubercular disease of the posterior process of os calcis. Wave-like loosening of tissue. Cavitation.

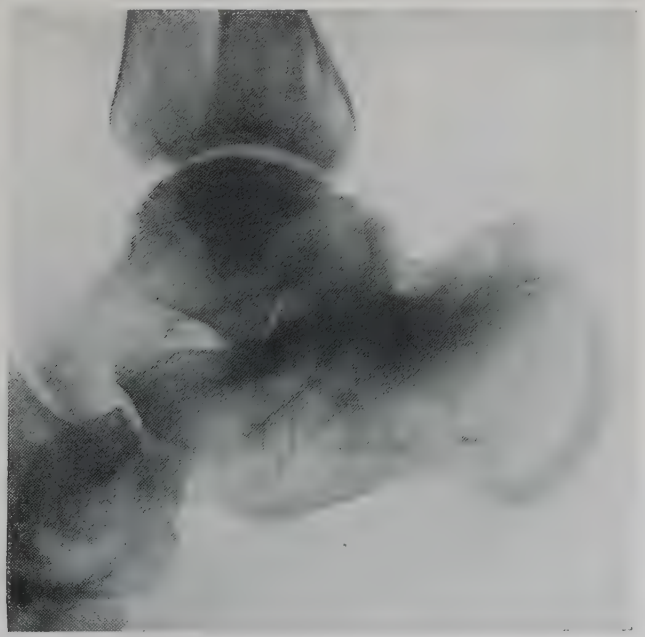


FIG. 220.—1½ years later: fully cured with a smooth bony cicatrix.

FIG. 221.—Girl of 16. Tubercular synovitis of the shoulder joint with secondary bone lesion; foci in the

FIG. 222.—Same. Recovery with solid bone scar, good structure and full return of function.

which often appears to reach from one epiphysis to the other, as it were across the articular inter-space.

Disease of the ankle joint.—Inflammation of this joint hardly ever leads to a complete stiffness. In cases approaching recovery, besides the already mentioned bone symptoms, we see the præ- and retro-articular infiltrations gradually disappear.

The extent of the final mobility of the joint closely depends on the primary extent of damage in the astragalus and in the epiphysis of the tibia. Attention must be drawn to the fact that a more localized patchy atrophy may often simulate granulations, especially in the tibia, where a sequestrum-like pattern is present. The scapho-astragaloid and the calcaneo-astragaloid joints (both frequent seats of disease) recover readily with a resulting synostosis, whilst the cuneiform bones are again inclined to form sequestra. Demarcating sclerosis and new bone, which follow selectively the old paths, are probably best seen in the os calcis.

Shoulder joint.—Displacement of the glenoid cavity may sometimes be observed and in these cases also we frequently come across dry caries. Wedge-shaped foci in the epiphysis of the head often display a chronic course. The secondary adaptability of this joint towards functional requirements is considerably less than, for instance, that of the hip joint.

Elbow joint.—As in the case of the knee joint, bone lesions give better functional results than simple tuberculous synovitis does. Often the newly-formed secondary joint functions well, its range of movements diminishing towards the periphery. The older the patient the nearer the focal lesion moves towards the olecranon (Oberst), and perforation into the joint becomes also anatomically easier. On the other hand, the prognosis is better in early childhood, because here it is the diaphysis and metaphysis that are affected.

Wrist joint.—The fungus of the hand invades rapidly the small intercarpal joints and erodes the carpal bones. We have to look out sharp for the time when the *X*-ray plate will allow the resumption of the use of the joint. But we must not wait for all the details to become visible; otherwise we shall run the risk of contractures. As soon as the disease has become quiescent and recovery has begun, careful movements must be started.

FIG. 223.—Tubercular disease of the elbow joint. Active stage.

FIG. 224.

FIG. 225.

Same case as Fig. 223. Recovery with articular function.

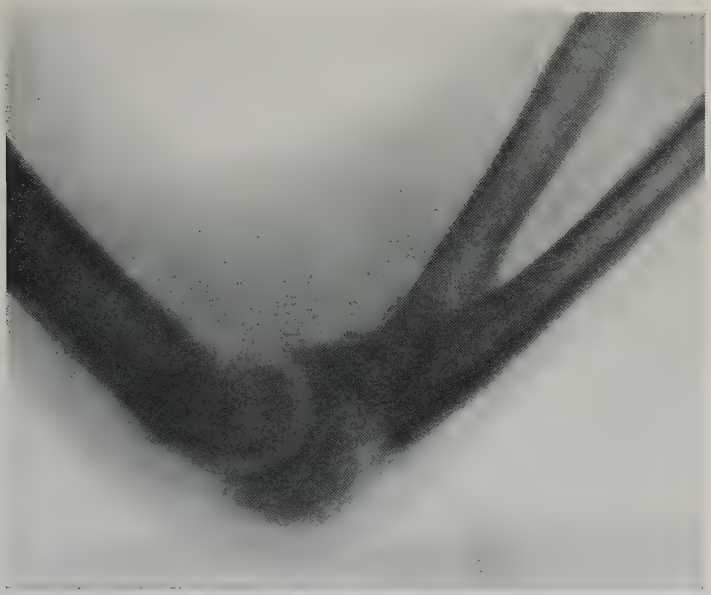


FIG. 226. -Disease of the elbow joint; fresh active stage.

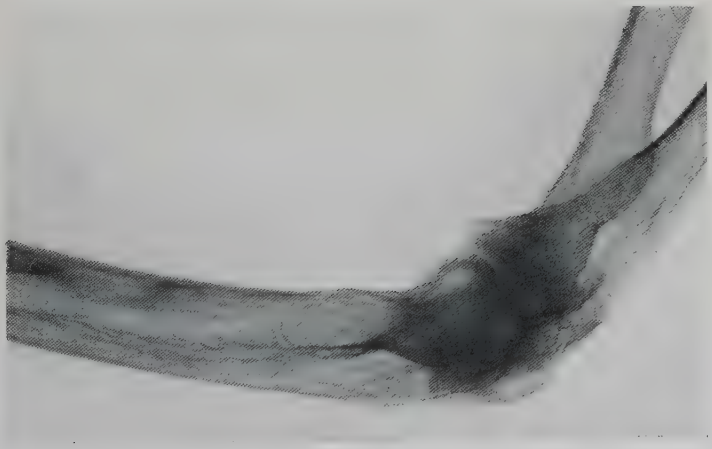


FIG. 227.—Same case as Fig. 226. Cured.

A primary lesion of the metaphysis of the radius calls for similar measures. The metacarpal bones seldom undergo shortening as a result of disease. It is interesting to note how successfully bone can defend itself. Diaphysis girders of about one-third to one-quarter of the original thickness preserve the length of the bone, in order to become trans-

Fig. 228.—Ostitis and periostitis of metacarpal II.

formed in the course of time into firm pillars. Small cavities become frequently lined inside with structural tissue, whilst superfluous fragments, sharp edges and projections succumb to natural absorption.

In *spina ventosa*, with its more osteo-myelitis-like picture and with its periosteal reaction so typical for diaphyseal disease, absorption, demarcation, and sclerotic thickening are the well-defined stages which one after the other lead to recovery.

However often the *X*-ray plates may suggest to us the

presence of sequestra, real separation of a bone fragment in these cases is very rare indeed. The huge periosteal shells are partly absorbed and partly apposed to the compact layer of the bone; and the diaphysis, apparently separated from its surroundings, proves itself unexpectedly to be very viable, and

Fig. 229.—Case Fig. 228 recovering.

it soon excels the neighbouring bones as regards the calcium content.

True sequestra which are plainly visible on the plate should be dealt with in the following manner. In cases of closed uncomplicated tuberculosis affecting epiphysis and metaphysis, sequestra should be merely noted, but otherwise left severely alone, because gradual absorption or reorganization renders our interference superfluous.

Where the sequestrum is enclosed in a bone cavity—which is often the case in the metaphysis—communicating with the

outer world by means of a long sinus, the above-mentioned processes are too rare to be seriously reckoned with. Whether the way is, anatomically speaking, open to a spontaneous elimination must be determined by the *X*-rays. The latter also show us the right direction in which the occasionally indispensable sequestrotomy should be performed.

Fig. 230.—Case Fig. 228. Cured.

The above are but a few brief remarks concerning the common localization of disease. The radiographic aspect of surgical tuberculosis is very manifold indeed and its study exceedingly interesting. In accordance with the character of the complaint, we do not witness here any marked reactions on the part of the organism. We deal with a subtle and fascinating filigree process, which pays great attention to details of structure. As regards radiographic technique, I may say that even the last word in skill could not be too good for this kind

FIG. 231.—Boy of 14. Left hand: trouble in metacarpals II and III, 2nd phalanx of the middle finger and metacarpal V. Right hand: base of all metacarpals, metacarpal II, 2nd phalanx of the index finger and 1st phalanx of the middle finger.

FIG. 232.—Same case as Fig. 231 cured after 10 months.

FIG. 233.—Multiple dactylitis (spina ventosa).

FIG. 234.— Case Fig. 233, cure after the lapse of one year.

FIG. 235.— Girl of 7. Swelling of articular ends of ulna and radius. Disease affecting most carpal bones. Dactylitis.

FIG. 236.—Same, cured. Restitution of normal bone structure and of articular relations.

of work. It is also desirable that photographs should be taken by the surgeon himself.

The improvement of the technique brought about by the Potter-Bucky diaphragm, constructed according to Bucky's system, has been so considerable that we should not like to do without it ever again.

IX. HELIOTHERAPY AND CONVALESCENCE

The clinical and radiological results achieved by heliotherapy justify the claim that this method of treatment represents the last word in orthopædic and conservative surgery. Through this method bloody operations and irreparable mutilations are prevented; the skin is left intact, as are the muscles and ligaments, so that the return of muscular function is hastened and harmony of the body's outward shape is restored. Thanks to this method, normal, employable people instead of maimed cripples are handed back to the community.

Heliotherapy is not reserved for the wealthy classes only; from the social point of view it is very economical, since it costs the community much less to obtain a complete recovery for its members by means of a rest cure in the sun and amidst mountain air, even though the treatment may last anything up to a couple of years, than to have their value permanently reduced through mutilating operations.

We cannot help quoting here the words of Professor Bardenheuer, a keen interventionist, who paid a visit to our establishment in Leysin. On the strength of his experience at the municipal hospital at Cologne, he now recommends the application of heliotherapy in the flat country whenever this treatment is possible, although he makes no secret of the fact that the worst cases must be sent into institutions situated in high altitudes.

"The nursing of patients in such places," he says, "costs the community little; in fact, it is cheaper there than anywhere else, when one considers the large number of tubercular people whose lives are thus saved and who are discharged as capable citizens—not as cripples; they return home without shortened legs, without stiff joints, and last but not least, without the complete loss of an arm or a leg, whilst those who lie in hospitals slowly decline and finally depart this life."

These words, coming from a man who, in the history of bone and joint surgery, has always occupied a prominent place, ought, surely, to carry great weight.

Professor Wittek, of Graz, expressed a similar view, by strongly recommending sunlight treatment in surgical tuberculosis, which contrasts with the (quite unfounded) statement that, since this malady attacked chiefly the poor classes, it should be treated by the cheaper and shorter operative method.

FIG. 237.—Sub-deltoid bursitis; bad general condition.

FIG. 238.—Same, cured after 8 months.

"Just because we are dealing here with children of poor parents," he says, "we should lay less stress on the brevity, and more on the quality of the cure; the latter should enable the individuals to fight for their daily bread by restoring the best possible function of their limbs. Every impartial expert who surveys the Leysin institutions with his own eyes must agree that such functional results as those achieved by sun treatment have not, up till now, been obtained by any other method."

Heliotherapy has thus acquired a social importance which is

in no way less than its therapeutic value. And rightly so, for the combating of tuberculosis is above all an economic and social problem. But the struggle against the disease itself is not over the moment the tuberculous lesions have healed. Great efforts have to be made to prevent the return of the trouble, which would undo the good results so laboriously obtained. With this end in view, it is imperative that an individual once attacked by tuberculosis should always live under such conditions as permit his recuperated system to continue defending him with its own natural resources.

Fig. 239.—Same case showing an athletic development of muscles.

Necessitous patients who, after a successful cure in the mountains or in the country, have been allowed to return to their workshops and their unhygienic homes are constantly threatened by the repetition of their trouble. The same influences which caused the first attack can just as easily produce the second. The relapse, however, can be prevented if the convalescent cases return to such conditions of life as will permit them the free use of open air and sunlight, even if the patients are thereby obliged to change their previous calling.

Gardening and farming are suitable for convalescent lung and bone cases more than any other kinds of work. Some might perhaps be inclined to think that the heavy work in the fields makes too great a demand on the strength of ex-patients, and

that not many of them would be able to stand it. Yet they all get so hardened by open air and sunlight, their muscles get so wonderfully developed, and such a high degree of resistance is achieved on their part that they are envied by many a low-country labourer. In fact, they prove themselves to be quite

Fig. 240.—Patient with 34 lesions. Ostitis, periostitis, adenitis with numerou sinuses. Advanced tuberculosis of both feet and of the right hand. Marke consumption of the left lung. Peritonitis. Cachexia.

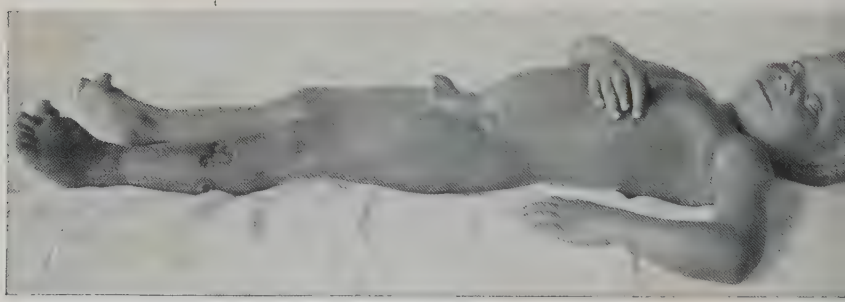


Fig. 241.—Same. Condition after one year. Recovery of weight and of gener health.

capable of performing most of the strenuous yet healthy agricultural duties.

In this way we not only assist them to keep healthy, but also render to the State a double service consisting of :

(1) Maintenance of a large number of people who would otherwise run the risk of relapsing and thus becoming a burden to the community.

FIG. 242.—Same case seen from the front: on admission.

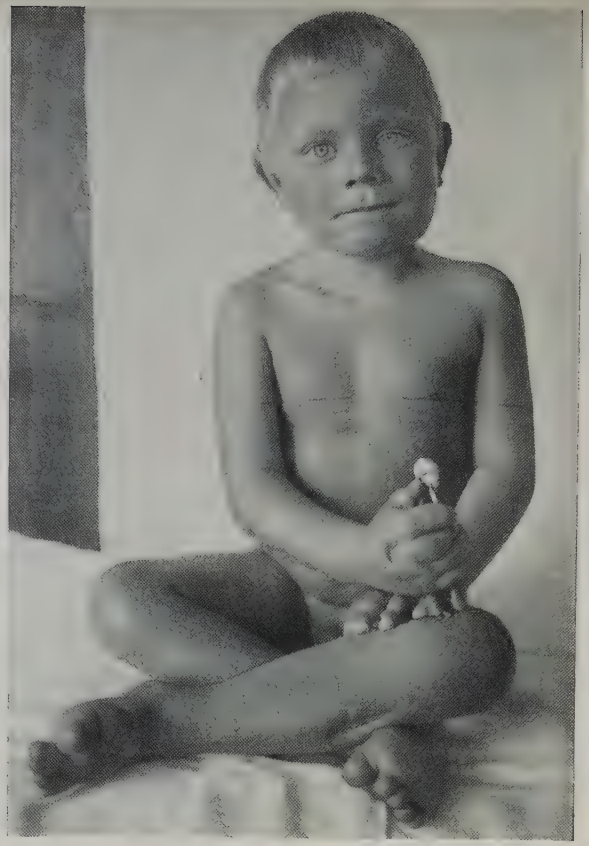


FIG. 243.—Same cured.

(2) Training of land workers of whom there has been a long-felt need.

These principles first found their practical application in a horticultural colony founded by me in March 1919 in Saxon (Canton Vaud), and intended for Swiss soldiers recovering from tuberculosis. These men were here engaged in early market-gardening, under the supervision of an experienced head

Fig. 244.—Same case ski-ing.

gardener, from whom they received instruction in gardening and vegetable growing. Their state of health improved so rapidly that after a few days of training they were able to perform a normal amount of work without effort or fatigue.

Through lack of accommodation this most unpretentious yet most encouraging venture in Saxon could not be developed further, although the work that was begun here was resumed later by a committee under the chairmanship of an army surgeon

FIG. 245.—Same case (×) gardening.

FIG. 246.—Same case (×) haymaking.

and placed on a much wider basis. This body acquired land in Canton Tessin, where a horticultural and farming colony has been started with results which augur splendidly for the colony's future.

First the progressive work cure in a sunlight centre, then the return to normal occupation on a farm—these are two definite milestones on the way leading to the complete reclamation of these valuable lives for their ordinary work. The public must also take some interest in this question and contribute to its solution along the lines described above. The ex-tuberculous patients become a useful capital for their community only if enabled to keep up their healthy condition; this they are only able to do in the country, where the conditions are favourable, thanks to the constant open air and sunlight facilities.

Fig. 247.—Same case as Figs. 240–246 10 years later. The patient spent some time in an orphanage in between. He has since become an exceedingly useful worker.

The back-to-the-land movement is no less desirable from the national-hygienic point of view than it is from the social. The undesirable congestion of our large cities, these "abysses of humanity," these centres of attraction that threaten to engulf all our vital forces at the expense of our physical and moral welfare, would thus be relieved.

The settlement of ex-tuberculous individuals on the land, where they can live together with their families, would also benefit the patients' relatives, so much so that some day we

might witness an apparently paradoxical result, namely, that, owing to the return of formerly consumptive people to the countryside and to the growing strength of their descendants, we may see a new and more wiry race arise before us.

X. PROPHYLAXIS

Prophylactic Sun Cure.

Being able, on the one hand, to cure the various, even advanced, tuberculous affections and to prevent relapses, heliotherapy can, on the other hand, render a still greater service to the community by preventing fresh outbreaks of tuberculosis.

According to contemporary views, tuberculous infection takes place generally in childhood. All, or nearly all, children (95%) have to face this infectious disease before reaching adolescence.

It is common knowledge that this ailment is contracted through the respiratory passages, but not infrequently also through the digestive tract. Borne by the lymph stream, the bacilli become at first imprisoned in the lymphatic glands. If the body has a good resisting power, the infection stops at the first glandular barrier, and leads to a kind of auto-inoculation, which gives the child a certain degree of protection for the future. The great significance of this self-protection is based on the now generally recognized theory according to which tuberculosis of adults is to be regarded in nearly every case as an endogenous re-infection, following the flaring up of an old trouble which may have dated back to their infancy and remained latent in the glands.

Since the germ invades the body in childhood, we have to fight the invader at this early age, and render it innocuous, so as to prevent its re-awakening later on. To do this it suffices to raise the power of resistance on the part of the child and at the same time avoid everything that might lower it.

Experience has taught us, however, that there is no more effective and reliable remedy to this end than sunlight treatment combined with open air and rational exercises. From the very first I have been recommending this method in crêches, orphanages, holiday colonies, and especially in public and

FIG. 248.—A school-in-the-sun.

FIG. 249.—" Wandering form."

private schools. In schools hygienic principles can best be imparted to children on account of the prevailing discipline which at home is so often difficult to maintain.

One must not forget that the physical development of the

Fig. 250.—A school-in-the-sun, near a chalet.

child has a great influence on its whole being; that the child's nature is very susceptible to outer influences and that the school is a mould in which it undergoes its first transformation.

The principles of hygiene to which the child has been accustomed at school become indispensable to it later on. They will

stick to it for the rest of its life, and it will inculcate them to its own children. In this way wholesome ideas will spread more and more, and in the course of time a stronger generation of people will grow up, one that will be more fit to resist tuberculosis.

In so far as schools tend to rob the children of the sun,

Fig. 251.—A school-in-the-sun in a natural park.

open air and unhindered movement, they become hotbeds of corporeal decay, in which the children's minds are educated at the expense of their bodies. How often has the better understanding of hygiene been able to prevent spinal curvatures, compressions of the thorax, and other vicious attitudes of the body, all caused by the faulty school forms? One or two hours of daily exercise in the sun, with an uncovered upper part of the body and bare legs, and frequent classes in the open, are measures easy to carry out and which, without interfering with

the teaching programme of our schools, can substantially increase the resistance of our growing youth.

In 1910 we started applying prophylactic sun treatment in Cergnat near Sepey (Ormont valley) by erecting a " school-in-the-sun " (Les Noisetiers). This institution was meant, on the one hand, to protect delicate and predisposed children against tuberculosis, and, on the other hand, to accustom our young convalescents to the normal way of living.

One of the house rules in this place is to allow the children to spend as much time as possible in the open, and especially

Fig. 252.—Tug-of-war.

in the sun. So that, instead of the teaching taking place in an enclosed room, lessons are given in the open.

In bad weather classes meet on an open balcony protected against wind and facing due south. In fine weather they meet in a field, and during the summer months preferably in the morning. On account of the profuse winter sunshine in the Alps, the more hardened pupils continue attending the " school-in-the-sun " uninterruptedly throughout the year.

The beginning is made with great care in order to safeguard proper acclimatization, because a lack of caution in this respect may lead to unpleasant complications.

Special attention is to be given to children who were at home accustomed to be coddled on account of their delicate health and who, in spite of their plentiful clothes (or because of them),

contract frequent colds, bronchitis or sore throats on the slightest change of temperature. We do not expose these children suddenly to the influence of air and sun, but we do it gradually, taking into account the fact that this new mode of living is

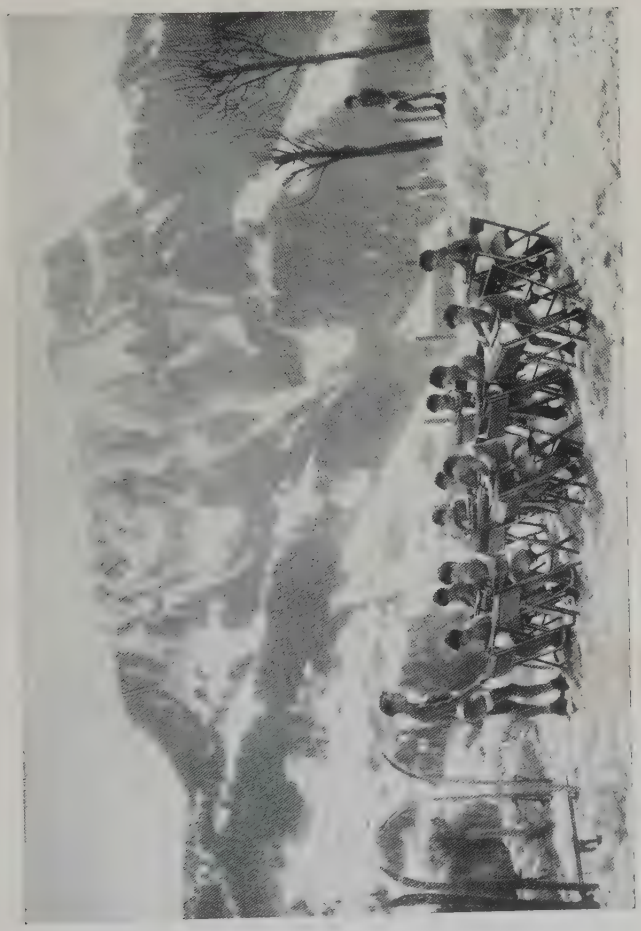


Fig. 253.—A school-in-the-sun in winter.

totally different from the one they were previously accustomed to. Our plan is as follows :

Moderate doses alternating with rest pauses, sun baths, short in the beginning then increasing in duration, and spreading from the lower limbs over the whole body.

These children look totally transformed after a very few

months. Their skin is brown, their complexion fresh, instead of the original anæmic pallor, their physical and mental vitality

Fig. 254.—"Wandering form" protected by a chalet.

has grown. The general state has improved materially owing to a better appetite and a sound sleep. The old signs of fatigue following the slightest exertion have disappeared.

Parallel with the above improvement an increase of hæmoglobin is noticeable in cases of anæmia; improved respiration, a more efficient pulmonary ventilation, increase of body-weight and a striking development of muscles are noticeable.

Fig. 255.—Playing in the sun.

Can any one wonder, therefore, that, in the face of such revolutionising results achieved at "Les Noisetiers" in sickly and exhausted children, we should very much like to see our idea of the "school-in-the-sun" extended so as to include the ordinary schools as well? The results would in such cases be

still more gratifying, because the majority of school children are strong and healthy and require merely preventive measures.

"Where the sun shines, there is no place for the doctor," says an old adage, and it certainly contains a large grain of truth, for it shows us the way in which to battle with this dreadful scourge of humanity. Indeed, the sun is an incomparable weapon which Nature has placed in the hands of every one of us with which we can all defend ourselves successfully against the manifold ailments threatening us at all ages.

Fig. 256.—Skating in the sun.

From now on air and sun will occupy the widest possible space in the life of each individual : not only in crêches, orphanages, public and private schools—where sun baths should become obligatory—but also in adult life : in barracks and towns in general.

Municipal authorities should see to the popularization of these ideas in schools and private dwellings, where great attention should be paid to an unhindered supply of air and sunlight. We would rejoice heartily if our authorities would give the start to a general movement directed towards abolishing the old-fashioned views still governing our building activities, particularly in the case of tenements erected for the poor. For

does not the sun shine for all people alike? And as the renowned poet Michelet truly says: "Of all flowers it is the human flower that needs sunshine most."

These municipal and housing reforms will certainly require much time and effort before their object is reached. But once the authorities and the people have grasped their burning necessity, their realization will be assured.

We are convinced that life in the open helps to maintain the health of the body. But without being too optimistic, we also believe that strengthening of the body is equivalent to elevation of the soul. We are far from wishing to introduce a muscle cult, for this would tend to lower the value of our work and its ideals; but we are all the same aiming at the ideal set up by our ancestors by trying to realize their famous motto "Mens sana in corpore sano."

The child's mind is often diverted from some unworthy or harmful occupation through the well-regulated, disciplined life in the open. At "the school-in-the-sun" he learns to read from the books of Nature. *Pari passu* with his physical strength the child's understanding grows wider, his character firmer and his soul more elevated. On the other hand, the appropriate, natural mode of living does not encourage those numerous habits which ruin human beings physically as well as morally.

The simple hygienic life develops in the young folks healthier instincts, nobler and manlier tendencies, by withdrawing them from the vitiated atmosphere of restaurants and other stuffy pleasure resorts where so many of them contract the germ of tuberculosis besides acquiring so many bad habits.

The well pigmented bodies of our children and adolescents should, like æsthetically erected temples, become illuminated by lofty qualities of heart and mind, forming one truly harmonious beautiful whole.

XI. HELIOTHERAPY OF NON-TUBERCULAR AFFECTIONS

Many years of practice have proved to me that no matter how weak an organism may be it can always be revived by sun treatment. Its soothing, reducing, bactericidal and sclerogenous properties have turned heliotherapy into a local treatment of choice. It fulfils all the requirements of orthopædic and conservative surgery, whilst at the same time it does away with irreparable mutilations and preserves muscular and articular functions. It may be applied in children as well as in adults. And, last but not least, it may be usefully adopted in various affections of non-tubercular nature. There have to be considered both general and local effects.

Since the commencement of our activities in Leysin, we have been keenly interested in the experiments of Bernhard, and we have also noted the great rapidity with which, as a rule, the wounds of our Alpine population heal up owing to the natural contact with air and sunlight. Both these factors have prompted us to apply sun cure systematically in all kinds of wounds and injuries.

The present book is meant to deal exclusively with technical and practical problems without engaging in any theoretical discussions. It is therefore our object to show how the sun destroys the germs of infection, simultaneously stimulating cellular function, and thus fulfilling the requirements of an ideal wound dressing. To prove this we shall quote results obtained by us in cases of all sorts of injuries, wounds, burns, fractures and varicose ulcers.

Whilst in some instances heliotherapy forms the basis of the whole treatment, in others it acts as a valuable adjuvant, subordinated to some other quicker and more active method. This is, for instance, the case in cellulitis, in whitlows, but especially in osteo-myelitis, in which sunlight allows us to cure

huge bone cavities better and quicker than any other known procedure.

No less important are the services we may expect from the sun cure in the domain of war surgery. Under its influence chronic indolent wounds heal up readily, and long-standing suppuration is brought to an end. Extraordinarily beautiful results may be obtained in compound fractures even when there has apparently been no hope of saving the limb. Sunlight acting directly against infection does away with a large number of amputations. Also in plastic operations and in cases of stiff joints sunlight can and does render considerable services.

Heliotherapy has found a new and fertile ground in the treatment of rickets and other allied diseases.

The technique of sun treatment is dealt with in this connexion mainly because the failures reported by different men have pointed to an insufficient knowledge of our methods. In order to get the best results, certain rules and instructions must be strictly adhered to. For simple as the cure may appear, it requires exact and careful watching. Yet if handled according to the principles laid down here, it cannot fail to yield very gratifying results to any medical practitioner who would choose to adopt it.

Heliotherapy in Traumatic Injuries

In contusions sun treatment is of great assistance on account of the active hyperæmia it creates and also as a stimulus to absorption; it is indifferent whether the bruising of soft parts is attended by a lesion of the skin or not.

Should the trauma have penetrated into the subcutaneous cellular tissue and injured a blood vessel, causing extravasation of blood into the loose tissue, or should extensive ecchymoses or even a large hæmatoma have formed, the application of solar rays will at first tend to soften the effusion. Tissues become better nourished and active hyperæmia facilitates absorption of serous exudates, whilst the phagocytic activity in the neighbourhood of the blood clot is stimulated.

The effect of irradiation on traumatic serous effusions is very marked indeed. Its first sign is the diminution of pain,

partly, no doubt, caused by the increased flow of blood from the deeper damaged part to the surface of the skin. Assisted by immobilization and elevation of the respective part, recovery progresses more rapidly under this treatment than under lead lotion and cotton wool.

Heliotherapy in Lacerations

Fig. 257.—A. D., 14 years old. Extensive, infected wound following fall on the head. Frontal bone exposed, the bare area being of the size of a florin. After shaving the surrounding parts and cleansing the wound with ether-soap, a thread was passed through the upper part of the wound flap. The thread is being held by the patient between his teeth in order to allow a thorough insolation of the wound. At night the wound is covered with a sterile gauze dressing.

Useful in treating simple bruises, our method is especially indicated in lacerations.

Every injury complicated by laceration of the skin offers very favourable conditions for infection. Traumatic impact directed to a bony projection produces a sharp-edged linear wound, which may heal just as quickly as a simple cut. Often, however, round this injury a zone is created in which the vitality of tissues is reduced through a damage of blood vessels or an injury of trophic nerves. On the other hand, antiseptic measures do not always reach all the germs, not to mention the fact that such measures are unable to prevent the infection from spreading to parts affected by local shock where all power of resistance has temporarily disappeared. Instead of increasing the vitality of tissues, antiseptics may, at times, damage the latter still more and thus support the development of bacteria. In this respect a "sun dressing," being a local and general stimulant, is distinctly of advantage.

Heliotherapy guarantees the strictest asepsis of all wounds otherwise not yet infected; but its application is no less

indicated where the damaged tissues have already fallen a prey to infection and suppuration.

It is a positive fact that sunlight is the most potent disinfectant, but what enhances its bactericidal properties particularly is the circumstance that besides killing the germs it also encourages cellular self-defence.

Phagocytic absorption and elimination represent the first phase in this defence of an infected wound. This, again, is

FIG. 258.—The wound is profusely granulating after 4 days' treatment. The skin flap was later on pulled upwards and the thread fastened to the head by means of small strips of adhesive plaster. It healed completely after 10 days.

FIG. 259.—Later stage. The hair was clipped short in order to expose the scar.

powerfully stimulated by active hyperæmia under the influence of irradiation, leading to hyper-leucocytosis, and is attended with a free secretion of pus from the wound surface.

Even the best covering dressing can never absorb enough wound secretions in order to render the drainage perfect. A dressing is always an impediment to the free flow of the discharge, and it interferes with self-purification of tissues and elimination of sloughing particles. Retention and absorption of toxins are thus encouraged, and consequently the

temperature goes up. Two conditions favourable to the breeding of bacteria are constantly maintained on the wound surface, namely, moisture and lack of light. Let us think of all these purulent membranes covering the whole surface of the wound right into its tiniest nooks and crevices, and re-forming with every change of dressings, and we shall understand the uselessness, nay, the danger of these dressings. That fœtid smell we so often perceive when changing dressings is merely due to retention and decomposition of stagnating discharges.

From the hygienic point of view also employment of large covering dressings in suppurating wounds is not without danger. And even if, in spite of prolonged suppuration, the wound should have commenced to granulate, the drawback of applying dressings is very considerable also at this stage. The material of which the dressing is made sticks to the wound and has to be pulled off, so that the young tissue is robbed of its uppermost protective layer. Thus the surface is afresh brought into contact with pus, and is hindered in its attempts at cicatrization. Finally, the change of dressings is often attended with acute pain and discomfort, justifying the look of concern on the part of the patients at the sight of the approaching dressing-table.

The " sunlight dressing," that is, the open-wound treatment, possesses none of all these drawbacks. Even a single exposure to the sun is sufficient to make the wound look better, and to give the patient a definite local relief. Pain and the sensation of tension and swelling disappear. As the appearance of the wound alters, so also the quality of the discharge changes; often after 2 to 3 days the composition of the latter becomes preponderatingly serous. In the end even this thin discharge becomes scanty, soon to dry up altogether. The whole wound area is covered with healthy granulations, which keep up a faint transudation, forming a fine pellicle. This becomes quickly epithelialized through centripetal immigration of the epidermal border and turns into a firm scar.

The originally abundant secretion as a rule diminishes speedily, soon to cease altogether, so that the wound acquires a dry appearance after a very few days of treatment. The site of the wound permitting, this desiccating aeration may

be continued also at night time, the wound being protected against contamination by means of a small wire netting. But if suppuration is still profuse, or the wound is unsuitable owing to its awkward localization (gluteal or dorsal regions and the extremities), wire netting is found inapplicable and an ordinary dressing is used instead, the wound being covered by several layers of sterile gauze for the night only. It is found frequently in the morning that the dressing was insufficient to take up all the secretion produced through the night. So that although the wound may have appeared to be on the best way to getting dry in the evening, a few hours were enough for the covering dressing to cause the wound to be bathed in pus again the morning after. The nightly use of dressings alone is able to delay the final cicatrization of the wound by at least a few hours.

Heliotherapy fulfils all the ideal requirements of a dressing suitable for suppurating wounds owing to :

(1) Its bactericidal and desiccating action,

(2) Stimulating vital tissue functions,

(3) The natural, thorough drainage and cleansing of the wound.

It might be added that in order to facilitate the free flow of wound secretions it is of advantage to alternate the horizontal posture with the vertical, or at least to accentuate the inclined position of the wound surface. Through this purely mechanical device, the process of elimination and cleansing is hastened and the formation of the scar brought to a speedy close.

The "sunlight dressing" surpasses the ordinary wound dressing in one more respect, namely, that of cost, which is, of course, much smaller in the former. The bactericidal, eliminatory, desiccatory and absorptive properties of sunlight ought to render the post-operative application of sun treatment in many surgical complaints a matter of course. In this group of maladies we count abscesses, cellulitis, whitlows, mastitis and osteo-myelitis.

Heliotherapy in Varicose Ulcers

The problem of varicose ulcers occupies a special place both in medical and social respects. For it is an extremely intractable complaint, one that turns its unfortunate victims into veritable pariahs amongst hospital patients. It is a constant occurrence to see a crowd of these cases besiege the entrance doors of out-patient departments. And yet they are almost ashamed to have to ask for treatment and attention. They go, and they come, and they go again without ever finding a cure for their trouble, because they are never thought worthy of proper hospital treatment. Yet it is they as much as anybody who deserve in-patient care, which they need so sorely on account of their misery, their poverty, their incapacity for work and their inability to obtain a cure without a proper rest in bed.

These ulcers along with tuberculous ulcers are the prototypes of the atonic form of tissue damage and both belong to that most obstinate category of wounds the healing tendency of which is delayed or even completely arrested through lowered tissue vitality. Here, again, it is the bactericidal and desiccating effect of the sun treatment that makes it a real treatment of choice.

During the early days of our work in Leysin and its environs we had a good deal of opportunity to examine cases of varicose ulcers amongst various types of people, mostly old persons, farmers, coachmen, labourers and others. Some of them had already undergone hospital treatment, from which they derived a certain temporary benefit. But on resumption of their former occupations the trouble broke out afresh. Later on they tried various ointments prescribed by numerous doctors; later still they gave a trial to different herbs and plants as recommended to them by local quacks and herbalists. The poorest of their number had already become resigned to their fate, and were content to keep their ever more unhealthy ulcers merely covered with dirty rags.

Most of these ulcers were of traumatic origin, extensive, with a slimy grey base, of an irregularly elliptical shape, situated on the antero-internal aspect of the leg, where the surrounding

skin was rough and adherent owing to hypertrophic dermatitis. It had nearly always been due to a blow or a fall, which produced a lacerated wound, and this wound could by no possible means be made to heal.

Patients with eczematous ulcerations (mostly elderly women) exhibited in the region of the calf, amidst distinct areas of a squamous or vesicular eczema, more or less deep, characteristically round ulcers varying in size from that of a sixpence to that of half-a-crown. Very old and neglected ulcers with rough bases, covered with necrotic masses, were discharging a thick, offensive fluid. All these patients, invalids as they were, decided as the last resource to try heliotherapy, the application of which was arranged as simple as possible. Many of these people were peasants and possessed either a small chalet with balconies, or a small garden, or a secluded piece of land. There they were placed on deck-chairs or mattresses, their limbs slightly elevated in order to facilitate absorption of the œdema. Acclimatization to air and sun was carried out gradually and individually, according to the condition of the patients, their age, their personal power of resistance and the condition of the ulcers themselves.

As a rule, ulcers with traumatic history made quicker progress, the exposures being here more frequent and lasting longer than in cases of eczematous ulcers. In this last variety irradiations were carried out with extreme caution and were given by stages, so as to avoid the appearance of solar erythema, for this had a bad effect on the surrounding eczematous areas. At first three short irradiations of only 3 to 4 minutes' duration were given, and in between the ulcers were merely aired. Finally a maximum total amount of 3 hours per diem was reached with intervals of 15 minutes between each 2 hours of insolation.

Heliotherapy was always followed by aerotherapy, during which the ulcers were undergoing a further drying process, whereby great attention has always been paid to the immobilization of the affected leg, also at night time, so as to support the circulation of the blood and lymph. Local action has always been improved by better circulation.

To avoid interruption of the treatment, the patients were transported of an evening to their beds, without however,

leaving their mattresses plus the inclined support for their legs. In order to hasten the recovery, the ulcers were left exposed to the drying influence of atmospheric air also at night. The leg was placed in a wide perforated splint and the ulcer protected with wire netting. At daybreak the patients were again shifted on to their balconies or into their gardens, where they resumed the treatment. We were always at pains to combine local and general sun baths, though not without having to overcome certain deeply-rooted prejudices and scruples in respect of the latter.

The effect of solar rays on varicose ulcers is manifold, the following being the main points :

(1) Pain is allayed already after the first one or two sittings.

(2) The cleansing, eliminating effect, owing to powerful hyperæmia, soon finds its expression in the increased purulent secretion. In dirty, slimy ulcers there is at first separation of necrosed tissues covering the base. Parallel with the advancing purification of the ulcer also the character of the discharge changes from purulent to sero-purulent, at last becoming purely serous, all this taking from 3 to 10 days.

(3) The hardening, tanning effect.

(4) Absorptive influence on the œdema and infiltrations.

The cleansing period is normally followed by the cicatrization period; sometimes, however, the latter begins before the first is quite over. The uneven, greyish surface covered with soft, atonic granulations becomes transformed into a brightly red, vascular surface. Now the epidermis begins to grow from the jagged, everted edges of the ulcer, and moves more and more with every day towards the centre. A finely mottled cuticle at first, it soon becomes a powerful scar.

In eczematous ulcers desquamation goes on parallel with the healing process and with the disappearance of the eczema itself. Parchment-like indurations of the skin pass away and the skin becomes regenerated and strong.

Bad traumatic ulcers were cured in this way within 3 to 4 weeks; very inveterate, eczematous ones in 4 to 6 weeks. The longest cure of all (9 weeks) was required in a case complicated by œdematous infiltration and papillomatous dermatitis.

The majority of our results were so encouraging that I have no hesitation in saying that varicose ulcers belong to the domain of heliotherapy, no matter what their cause. It is all the same whether it be a trauma, a simple laceration, or a deep contusion with subsequent breaking of the skin. It is also of indifference whether the ulcer had originated through the rupture of an enlarged vein, and whether suppuration was due to phlebitis or lymphangitis, or, finally, if such paltry skin troubles as furuncles, eczema, etc., had given rise to ulceration. The sun treatment should remain the method of choice in all these cases, because, on the one hand, it exercises a healing influence on the most obstinate of ulcers, and, on the other hand, it is of prophylactic value by helping to prevent the formation of fresh ulcers.

This prophylactic action —or, more correctly, the inhibiting effect it has on the ulcers—is quite easy to understand, since it deals with all three elements : (1) the wound itself, (2) the infection of the wound, and (3) the trophic disturbances which lower the vitality of tissues at the site of the wound.

Syphilitic Ulcers

It is well known that the leg is also a favourite seat for syphilitic ulcers. In combination with specific treatment, heliotherapy considerably hastens the recovery in cases of gummatous ulcers. We have seen multiple and extensive specific ulcerations heal within a few weeks. These were often instances of very debilitated people who had had this trouble for a long time, and whose low state of health rendered a continuation of the specific treatment difficult. One case experienced so much pain with each change of dressings that he had to have a morphia injection every time. The extensive ulceration was covered with filthy crusts and the raised edges were surrounded by a few salmon-coloured bridges of skin tissue.

In such cases irradiation is a veritable blessing, on account of its complete freedom from pain and fear. The method of application is here precisely the same as in varicose ulcers, the

FIG. 260.—Syphilis of the sternum.

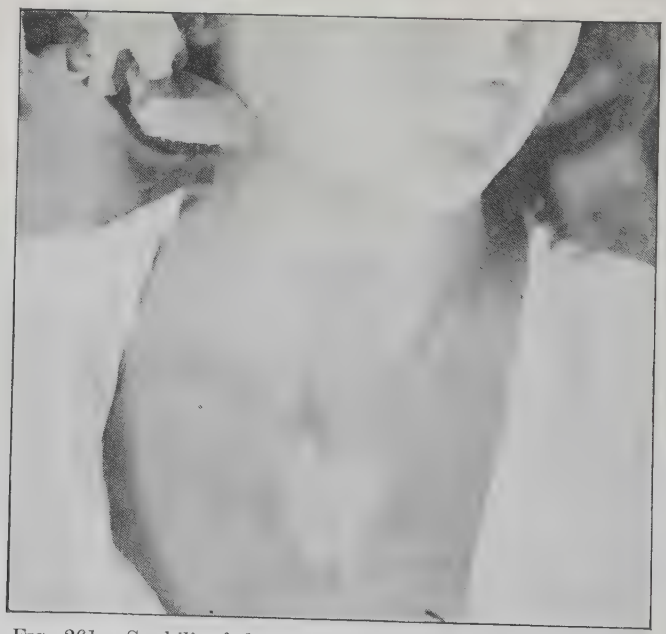


FIG. 261.—Syphilis of the sternum cured by sunlight and specific treatment combined.

affected limb being also elevated. In every case sun treatment is given along with mercury or salvarsan.

Hess and others have lately emphasised the importance of phototherapy in connexion with this malady.

Burns

The sun treatment leads to quite satisfactory results in cases of burns. Instances of complete charring of the epidermis and the underlying muscles are excluded from the present consideration, because no records of such cases are available to us. But the slight superficial degrees of damage caused by electricity, sun rays, hot fluids or solid substances and the effect of heliotherapy on them have been studied by us.

The following are the degrees of burns which we have been called upon to treat :

(1) Superficial erythema without formation of blisters.

(2) Inflammation of skin with separation of epidermis and formation of blisters with serous contents.

(3) Destruction of isolated parts of the skin down to the subcutaneous connective tissue.

It might appear paradoxical to suggest heliotherapy as a remedy for solar erythema. At the beginning of our career, when our technique had not yet been fully developed, we often came across cases of solar erythema, and we tried for it all the commonly employed measures, such as compresses, glycerine, vaseline, lotions, etc., besides also making a pause in irradiation. Some patients, however, who were in a hurry to get thoroughly pigmented discarded these applications and continued taking sun baths as if nothing had happened. After two to three more exposures the erythema disappeared, having passed into a bronzed discoloration of the skin, the latter now no longer sensitive to the scorching effect of the sun. In cases treated by the usual methods erythema lasted much longer, sometimes a week even, and was followed by desquamation.

The effect of heliotherapy is still greater whenever the burn was caused by some potent agent, or was the result of a prolonged action of a less destructive medium, so that bullæ have appeared on the site of damage. The soothing influence of sun rays is all the more desirable as the pain in these cases

is usually intense. The affected region is insolated for only a few minutes (3 to 5), and, at first, through a layer of gauze; for the rest of the time it is left exposed to atmospheric air. The serous fluid within the blisters becomes absorbed, the bullæ collapse and dry up. Two to three days later—under the same treatment—the loose skin separates in strips and exposes the germinating layer of skin, which gradually covers over with epidermis and soon acquires the tint of the remaining pigmented skin, without leaving any visible scars behind.

Should scabs or extensive, deep ulcerations with jagged edges have formed, the healing of which is so slow when ordinary remedies are employed, sunlight treatment will always lead to a rapid and painless cicatrization.

Also suppurating wounds resulting from burns of the third degree came under our care. This is a notoriously painful condition when it comes to the change of dressings; gauze saturated with serous discharge and afterwards hardened sticks to the wound, so that even a careful removal damages the tissues and provokes oozing of blood from the surface and the edges of the wound. Whoever may have witnessed the martyrdom of scalded children will appreciate the fact that this has been done away with, thanks to the use of sun treatment.

Again, we see that the first few applications arrest secretion, the wounds dry up, having formed a fine covering layer which soon renders them insensitive. At night wire netting or loosely applied gauze is used as a protection.

The first sittings must of necessity be very short, 5 minutes being the maximum, and they are repeated three to four times during the morning. For the rest of the day, weather permitting, the wounds are merely aerated. Only short séances have the desired analgesic property, an overdose of sunlight producing immediately intensive hyperæmia of the affected area, pain becomes intensified and hæmorrhages take place from the wound surface.

The scars following bad burns, like those of other wounds treated here, are smooth, soft, elastic and of a delicate pink hue. They show, as a rule, no tendency to retraction or keloid formation, both being very frequently the result of other forms of treatment.

Heliotherapy and the Treatment of Fractures

The favourable influence of the sun in cases of fractures has been well known for a long time. Thus Percy noticed that fractures in patients who lay in a secluded corner of the ward, where sunlight never reached, united very slowly. Consolidation of the broken bones took a normal length of time, however, as soon as these cases were moved to the sunny parts of the ward.

Also Hamilton pointed out this interdependence of sunlight and consolidation, and in his work on fractures he recommended that fractured limbs be allowed to come into free contact with air and exposed to sunlight at least once or twice during the day.

We have made similar observations in this respect and have made it a rule always to adopt insolation in those cases which could be so treated, without in the least interfering with the necessary immobilization and fixation of the bone ends.

In fractures of the upper limb, which are commonly put up in splints, plaster of Paris or water glass, a certain degree of consolidation is best obtained before sun treatment is commenced. The latter is found of immense value as a stimulus to the formation of callus, to the absorption of œdema, to the recovery of muscles in overcoming contractures and the re-education of joints.

In the lower limb, where, according to Bardenheuer's method, an exact adaptation of fragments through extension is possible, or where a Zuppinger's splint can be employed, our cure can be brought into play quite early. It is particularly indicated when trophic disturbances set in; also in cases of local osteomalacia of a traumatic origin (Sudeck's atrophy), in which one frequently sees a progressive rarefaction of the compact layer of bone around the ends of the fragments, causing delay in callus formation and often even completely preventing the latter and giving rise to false joints.

Thanks to the active hyperæmia set up by our method of treatment, this traumatic decalcification can be arrested, and the necessary equilibrium between construction and destruction

of the trabeculæ as required by a normal process of union established.

This striking improvement of osteogenetic processes by heliotherapy would appear to suggest its use in all cases of fibrous and fibro-synovial pseudarthrosis. It is common knowledge that in these cases almost everything on earth has been tried in order to stimulate the tissues interposed between the bone fragments, with the intention of bringing about ossification. And, whatever the merits of all the other remedies, this can undoubtedly be achieved in a high degree by the action of sunlight. This holds good also as a post-operative measure in cases of shortening, after previous reduction by surgical means.

Besides being an adjuvant to normal callus formation, heliotherapy has also a beneficent influence on faulty callus formation, which may be giving rise to pain and neuralgia, either due to pressure on the neighbouring nerves, or caused by protracted inflammatory changes in the area of the fracture.

In intra-articular fractures and in fibrous ankylosis we see articular function return either fully or partially. Also general disturbances following the unavoidable fixation of limbs, such as residual hæmatomata, infiltrations and œdema, are forced to disappear under the action of sunlight.

Next to simple fractures we see comminuted fractures do exceedingly well under our treatment, combined with strict and methodical immobilization. In this class of fractures sunlight assists in preserving the aseptic condition of the wound, if adopted from the very first; it hastens absorption of extravasations, and encourages the formation of strong callus, cementing together all the loose splinters. Still more evident is its effect on compound, penetrating and infected fractures, without, however, coming into conflict with any of the recognised surgical manipulations. For, after all being said and done, it is the surgical interventions that surpass all other methods in these cases. The more septic the wound is, the quicker must be our attack. Heliotherapy, like all the other expectant methods, must step back in the face of an open fracture with signs of commencing sepsis, especially if the wound has already become a source of purulent discharges

or of gas gangrene; or when the mauled flesh, covered with mud and bits of tattered clothing, appears to be turning necrotic; or when infiltration and retention of pus are producing rises of temperature, and rigors point to a commencing toxæmia or even septicæmia. For only after a complete and rigorous cleansing of the wound has been carried out, after the whole area has been drained by incisions and counter-incisions, the focus of disease isolated and necrosed splinters removed, can sun cure be initiated. After immobilizing the limb by means of extension or by applying a splint with a large window, the gaping wound may be exposed to the sun in such a manner that the latter can penetrate into the deepest crevices of the damaged area.

At first all necrosed tissues are expelled *en masse*, wound edges become clean, temperature falls, general condition improves. Pain is lessened, dressings become painless.

After each sun bath the wound is covered with a compress wrung out of hydrogen peroxide or saline. As soon as the purulent discharge has changed to serous, a thin layer of gauze is all that will be required at daytime, a thicker layer being employed at night. As a rule within 8 to 10 days wire netting is applied to protect the wound and to allow aeration. The duration of recovery is considerably shortened and functional disturbances, so often witnessed after the customary methods of treatment, are avoided.

Heliotherapy in Cellulitis, Whitlows and Septic Abscesses

As a post-operative measure in these affections sun baths are specially commendable again on account of their bactericidal, cleansing, sclerosing and absorptive properties. Particularly the diffuse variety of cellulitis, with its tendency to spread into the depths and to produce tissue death on a large scale, derives great benefit from sunlight treatment, following upon surgical interventions. As soon as large incisions have emptied the pus that had collected in the deep layers of cellular tissue and laid bare the affected area, the sun can be given a free play. It is advisable, however, to leave the

drainage tubes *in situ* sufficiently long to prevent superficial cicatrization, which might lead to a renewed retention of pus.

Analogous with the treatment of lacerations we see here, in the first instance, a thorough elimination, but with the difference that here pus itself brings to light the various necrosed portions of tissue, sloughs, etc. The whole field participates in the general disappearance of œdema, all the niches and corners which had been laid open by the surgeon's knife are now purified under the influence of the sun.

Fig. 262.—Whitlow with necrosis of the terminal phalanx.

Fig. 263.—Case Fig. 262 cured within 6 months.

We have had some excellent results from our treatment in a large number of cases which have been discharging from their synovial sheaths and bursæ, or from necrosed bones for a very long time after the operation. A few sun baths only were necessary to relieve the tension of tissues, and the final scars were as pliable and soft as usual.

All kinds of whitlows : subcutaneous, synovial, or periosteal, are sunned after previous incisions. This procedure may frequently save necrosis of the terminal phalanx of the affected digit.

Our treatment is equally indicated in cases of periostitis and ostitis of either septic or aseptic character, be it in the initial

stage or after an operation. The irradiation acts, on the one hand, as a regenerator by stimulating cell formation, and, on the other, it produces phagocytosis, which again aids the elimination of the virus and dead tissues.

Heliotherapy in Osteomyelitis

Here the results of sun sure, as adopted after a successful opening up of the bone, belong to the finest on record. Ever since the beginning of our surgical practice in Leysin, these cases have been subjected by us to heliotherapy. In acute cases we favour immediate and energetic intervention as soon as localised pain, combined with initial swelling, suggest the existence of pus within the medullary cavity. We follow up the opening of the diaphysis by a thorough turn-out of the cavity. In chronic cases the wound is exposed to the sun after the removal of sequestra and arrest of hæmorrhage. The antiseptic property of sun rays is brought into action and granulations are vastly encouraged. Incidentally, the deep and painful plugging of bone cavities is thus avoided, and the duration of this otherwise long-drawn-out malady is cut short.

Since the results of our method have been extraordinarily good, a brief description of the technique may well here be given.

After the bone has been opened, the cavity is tightly plugged for about 36 to 48 hours to ensure stoppage of hæmorrhage. At the end of this period the plugging is removed and the medullary cavity is at first exposed to open air for one day. Immediate insolation is not to be recommended, as it might lead to small hæmorrhages from the bone surface. Sun cure is commenced on the second day, beginning with short sittings of about 10 minutes each, repeated three to four times the same morning. For the rest of the day the wound is merely aerated. For the night it is protected by means of a gauze dressing. The next day the sittings are prolonged by a few minutes. Great care is called for in order to prevent serous transudation, which might swamp the medullary cavity, together with the rest of the wound. What is required in these cases is not so much the decongestive and eliminatory

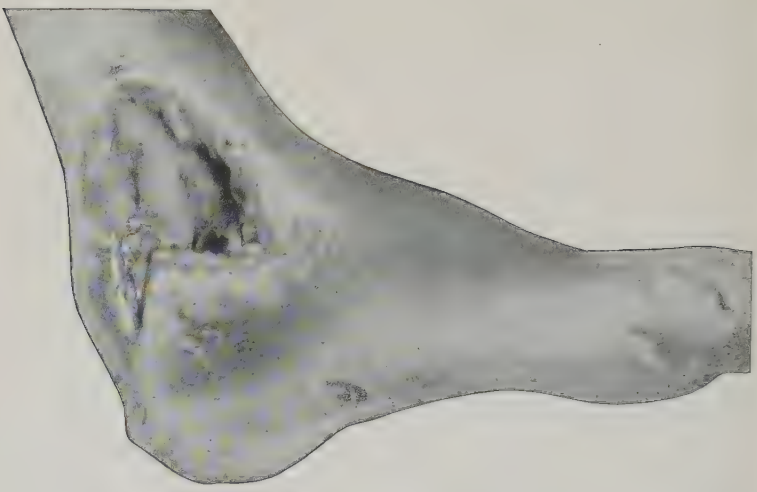


FIG. 264.—Osteomyelitis of tibia after opening.

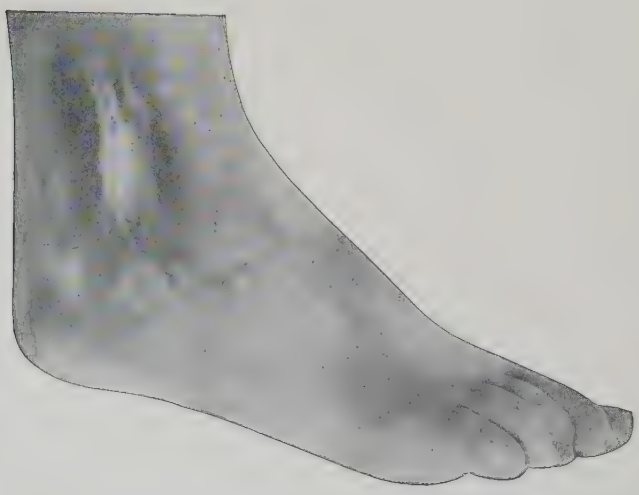


FIG. 265.—Case Fig. 264 healed and epithelialized in 6 months.

influence of the sun as its bactericidal and stimulating properties, which engender the growth of granulations. This latter effect becomes visible already after a few days and goes on uninterruptedly to the end. For, unlike other methods characterised by a torpid appearance of the wound surface, there is no standstill of the healing process as initiated by sunlight. *Pari passu* with the above, the skin and the muscles also undergo remarkable development; they become supple and partake in the filling out or bridging over of osseous defects.

During irradiation the wound edges are kept wide apart by means of specially constructed hooks. After the removal of the original plugging no fresh tampons are introduced, a fact much appreciated by the patients.

Post-operative application of heliotherapy may be undertaken with good results in mastoid disease. The head is protected by a white cloth perforated opposite the desired spot. Otherwise the same principles obtain here as elsewhere.

Sun Cure in Gunshot Wounds

During the Great War sunlight played no inconspicuous part in the treatment of gunshot wounds at the various hospitals and dressing stations and many military and civil surgeons have written on this subject. I myself contributed in the *Bruns Beiträge* (1916) to the general knowledge of the importance of sun treatment in war injuries. But as these cases have lost much of their interest since then, the reader may as well be referred to the war literature for full details, which are here omitted.

Sun Cure in Rickets and other Dystrophic Bone Diseases

The ætiology of rickets has considerably gained in interest of late. As has been shown through the recent researches, this malady is largely due to lack of light and lack of air during the period of growth. As far back as 1897, Feer pointed out that children inhabiting mountainous parts of the world suffer seldom, if at all, from rickets.

From the very first I endeavoured to emphasise the great

importance of heliotherapy, both as a preventive and therapeutic measure in rickets, as laid down in my earlier works. Later investigations have completely borne out my opinion. Whilst for a long time many had been inclined to see the main ætiological factor in the lack of vitamins, one is now more and more compelled to acknowledge the importance of light.

It was the American authors who paid particular attention to this subject. With an appropriate diet they found it possible to make young rats rickety by keeping them in darkness. If, however, the animals, still on the same diet, were

Fig. 266.—Rickets and scrofula.

Fig. 267.—Same case 10 months later.

exposed for 4 hours to sunlight, they did not develop rickets. The Americans concluded therefrom that sunlight enables the cells to function properly by compensating the faulty diet.

Hess and Unger, two American investigators, are convinced that infantile rickets can be cured without any change of food, merely by the action of sunlight pure and simple. In this connexion it is interesting to quote some figures from a work by Hess and Gutman. The phosphorus content of the blood in healthy children is 4 mgs. per 100 c.c. of blood. Rickety children show diminution : 2·8 to 3·4. On systematic exposure to sunlight for $\frac{1}{2}$ to 1 hour daily, the phosphorus content rises until it reaches the normal. This phenomenon can be proved both clinically and radiologically.

According to our experience, the sun exercises the same positive influence on the local and general condition of rickety children as it does on the tuberculous patients. The whole body becomes stronger, whilst the deformities of spine and limbs are amenable to correction, and especially at the commencement of the disease. Correction is still possible at a later stage if the cure is combined with rational conservative orthopædic surgery. In order to relieve the mechanical cause of deformities, or in order to prevent them altogether, we like to prescribe complete rest in bed straightaway. The sick child is allowed to move its limbs about freely and assume every posture it likes except the vertical. Spinal deformity cases, especially kyphosis, are placed in the ventral position every day for a few hours, this habit having been previously slowly developed, similar to spinal caries cases. The patients rest their elbows on a wedge-shaped cushion placed underneath the chest. Physiological lordosis is thus accentuated and kyphosis more and more corrected.

The sun encourages development of muscles of the neck, shoulder and back in general. This strengthening of muscles and ligaments supporting the spinal column is equivalent to a muscular corset holding up the thorax. The latter, as well as the abdomen, is assisted in its development by alternating irradiation of back and chest. The rosary of rickets disappears; the enlarged belly diminishes, and flabby muscles are replaced by firm ones. Sunlight also disperses the epiphyseal enlargements of bones, especially round the wrist joints. Deformities of the lower extremities can be equally overcome by means of rest and massage.

After a very few months of sun cure the body of a rickety child acquires the normal, harmonious lines of a healthy strong child. Evenly tanned skin covers a supple and resistant musculature, whilst the skeleton has lost all traces of its previously faulty shape. And now only do we allow walking exercises to be introduced in a progressive fashion. The feet are clad with sandals, which raise the arch by means of special supports placed inside.

Sun cure is thus the method of choice in rickets; but it is also a valuable remedy in bone and joint deformities of adolescence:

scoliosis, coxa vara, genu valgum, pes valgus, etc. The majority of these deformities present changes in the osseous system resembling rickets, which fact prompted us to term them delayed rickets. The main clinical points common to all these maladies are the insufficiency of muscles and ligaments, also disturbances in cutaneous circulation, as evidenced by cyanosis of the extremities. These troubles are amenable to heliotherapy, which effectively supports orthopædic treatment, as in the case of infantile rickets.

Mention must be made of the quartz-lamp treatment, as suggested by Huldschinsky, which is one more proof of the importance of light in treating this disease. Otherwise, I share the views of Wittek, who says that rickety subjects are far too numerous to be brought under artificial light treatment and that therefore there is a great need of the universal practice of natural sun cure.

Joint troubles are another indication to our treatment. Besides the tuberculous variety, we find also syphilitic arthritis apparently amenable to it. Sprains, contusions, hæmarthrosis, hydrarthrosis, etc., are also successfully handled in this way. In a case of hæmophilia we treated an articular effusion with much success: the hæmatoma, which was situated not only inside the joint, but also all along the epiphyseal line, was rapidly absorbed. The generally anæmic and debilitated state of the patient, needless to say, had also benefited in no small measure.

Arthritis deformans has yielded repeatedly to heliotherapy. Synovial effusions and spontaneous attacks of pain disappear or else become lessened, as also do the swellings of articular bone ends, creaking of joints, muscular atrophy and neuralgic pains radiating along the nerve trunks.

We must take due note of Buschke's observations, who found sun baths a good adjuvant when treating gonorrhœal arthritis, especially during the summer months. He put up the affected joints in splints with anterior windows and exposed them every day for a few hours. On the other hand, Buschke was satisfied neither with the results of artificial Alpine sun (quartz-lamp) nor with the *X*-rays treatment of this class of cases.

Sun Cure in Gynæcology and Dermatology

Certain gynæcological troubles, and above all those connected with the appendages, as well as pelvic peritonitis of non-

Fig. 268.—Psoriasis.

Fig. 269.—Same case 6 months later.

tuberculous nature, can derive definite benefit from cautiously administered sun treatment. This method is still very little known. Yet it should, in my opinion, be tried in all suitable cases. Local irradiation directed to the exudates in the true pelvis hastens their absorption and reduces pain, whilst the

local inflammatory condition improves also indirectly as the general health gets better.

Skin diseases, and in particular eczema, impetigo, acne and boils, are amenable to sun cure. For light, although strengthening tissues, kills bacteria and weakens parasites. A well-pigmented integument is less suitable an abode for bacteria and parasites to settle in and to flourish. Pityriasis and psoriasis are favourably influenced by sunlight.

FIG. 270.—A girl with Little's disease. Spastic paralysis. Contracture of thighs in flexed position with maximum abduction and internal rotation. Double pes equinus and right pes varus. Epileptoid twitchings. Walking quite impossible even when supported under the arms.

SUN CURE IN DISEASES OF THE BLOOD

It is a constantly observed fact that hæmoglobin and red blood corpuscles augment in our sunning patients. How much of this is due to the direct action of the sun and how much to the influence of the Alpine climate cannot be answered. Riedel set out to determine the effect of light on the blood count. This he studied on the clinical material supplied by Ludloff's clinic, in

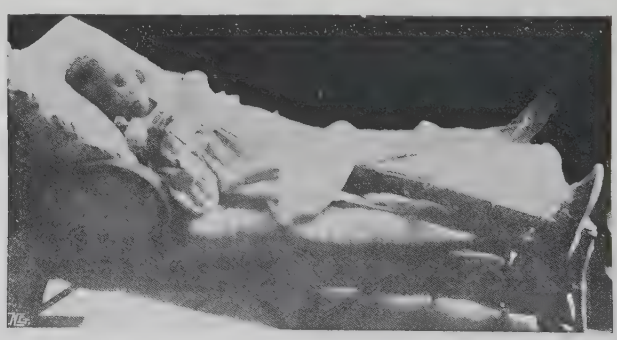


FIG. 271.—Correction of faulty position. Progressive education of muscles. Passive and active flexion and extension of feet and legs. Immobilization of the limbs in adjustable and removable apparatus which permits of sun treatment.

which case the climatic factors were excluded, and he arrived at the following results :

"The hæmoglobin content of blood is in every case undoubtedly increased as the result of sunlight action . . . Almost as uniform is the behaviour of the red blood corpuscles. In almost all instances their number goes up considerably, a fact which it was impossible to attribute to the improved general condition alone." Riedel draws herefrom the conclusion that in Alpine climate the increase of the red blood corpuscles and of the hæmoglobin does not depend on the fall of atmospheric pressure alone, but that it is also to be attributed to the solar radiation in conjunction with the prevailing climatic factors. It is clear, therefore, that primary as well as secondary anæmia are to be regarded as suitable maladies for our form of treatment.

Fig. 272.—Condition of the same girl after a year. The child is making her first walking attempts in apparatus which will be completely discarded later on.

We had no opportunity to study pernicious anæmia. On the other hand, we have had occasion during the last few years to treat quite a number of cases of lymphogranuloma, which had been sent up to us labelled as tuberculous adenitis. In all these cases sun cure was adopted systematically in conjunction with *X*-rays. Some of them were very bad, advanced types which offered little ground for a lasting therapeutic impression. Others, again, displayed excellent results, in spite of having in some instances developed bone metastases. Individual successes exceeded far and away what one was accustomed to see after *X*-ray treatment alone. Whilst the trouble itself appeared to have come to a standstill, general condition improved. We were able for 8 years to follow up the case of a man of 28, who on admission presented malignant

lympho-granuloma of the sternum and whose clavicular and axillary glands were extensively implicated. Intensive applications of *X*-rays and 12 months of sun cure rendered him free from symptoms for 4 years; moreover, he became fully capable of work. His efficiency was best proved by the fact that he climbed mountains and rode a bicycle.

We do not claim to have ever achieved a real cure in these cases, but many a lasting improvement. It appears as if consistent and prolonged sun cure (at least in those cases which had not gone too far) exercised an arresting influence on the, as yet

Fig. 273.—Convalescents on skis.

unknown, virus of the granuloma, thus explaining the long periods of quiescence in the development of this disease. This, of course, is one more reason why treatment should be commenced early and carried on with vigour and perseverance.

We lack the necessary experience, as far as leukæmia proper is concerned. In the third edition of his manual, Nägeli writes, in the chapter on Leukæmia: "In a few cases I found heliotherapy of some use when applied directly to the spleen. Especially in the sunny summer of 1911 I saw surprising results, such as prolonged rise of hæmoglobin and of the red cells, etc., an extraordinary improvement of general health, and an amazing diminution of the spleen which had previously resisted the action of *X*-rays." Nägeli's experience should encourage

us all to pay more attention to the treatment of blood diseases with sunlight.

Heliotherapy of non-tuberculous affections has not yet penetrated into the wider circles of medical men. The above-quoted cases, however, should show how big a field opens up to us in this direction.

XII. CONTRA-INDICATIONS TO SUN CURE

Contra-indications to sunlight treatment may be briefly summed up as :

Cardiac and Renal Troubles

Cardiac insufficiency, even in its initial stage, is an absolute contra-indication to Alpine heliotherapy. Each case of valvular disease, advanced myocarditis and bad arterio-sclerosis is unconditionally ruled out.

We also decline absolutely to have anything to do with nephritis. And above all if the latter is accompanied by arterial hypertonus or by symptoms of a commencing break-down of circulation.

Advanced bilateral renal tuberculosis, in which uræmia threatens to set in, must not be treated by our method.

Lung cases of the nodular type are unsuitable; those in which exudative manifestations predominate are also excluded for obvious reasons.

On the other hand, we do not consider the following to be of disadvantage :

(1) Advanced age; though strict control and exact observation are here necessary in order to avoid powerful reactions.

(2) Amyloid and other degenerative forms. For also in these cases the cure is free from danger if the patients are closely watched.

(3) Pulmonary tuberculosis of the cirrhotic, fibrous type.

(4) Fever, as the manifestation of a certain activity of the disease may delay the cure, but is not to be taken as a contra-indication *per se*. In the face of very high temperatures one has to bide one's time, sometimes for several weeks, during which period the normal level is gradually reached, especially if appropriate orthopædic and dietetic measures have been adopted. Sub-febrile cases, presenting otherwise regular charts, not attended with any material changes of the general condition of the patients stand a "creeping" sun cure very satisfactorily.

XIII. THE SUPPORTING ACTION OF ACTINOTHERAPY

By Ernst Amstad, M.D.

Although actinotherapy plays but an unimportant rôle in the plan of treatment as adopted in Leysin, yet for the sake of completeness it seems desirable to state our attitude to it on the strength of our experience.

(*a*) Artificial Sources of Light.

The original conception of the power of ultra-violet rays led Kromayer (1906) to the construction of the well-known lamp, so extensively used by dermatologists. The quartz lamp proper, which erroneously received the name of the " artificial Alpine sun," was built on the principle of Kromayer's lamp, although it cannot be employed for purposes of compression treatment. The spectrum of this lamp is totally different from the solar spectrum, and the best part of the rays produced by this lamp becomes absorbed by the uppermost layers of the skin. According to the latest research on animals (Gassul), however, it appears that a certain amount of deep penetration cannot be denied to it.

Has the quartz lamp any effect on the general condition? Many observers reply to this question in the affirmative, having recorded increased body-weight hæmoglobin index and red cells; others, however, are very sceptical with regard to the alleged achievements of the quartz lamp. Personally, we have no real need for it, having two such potent factors at our disposal as Alpine air and sunlight, with which we can improve the general state of our patients. Sometimes, however, we employ the lamp for purposes of local irradiation of very superficial morbid processes, such as scrofuloderma, tuberculous wounds of the skin, etc. In practice one can

convince oneself very soon of the fact that the results of the quartz lamp cannot even be compared with those of the sun.

Latterly attempts have been made to invent sources of light the spectrum of which would approach that of the sun. These lamps have been called "Spectrosol," "Sollux," etc., and they contain, amongst others, also the red and infra-red rays. In some hospitals both kinds of lamps are being used. For instance, Ludloff, a professed phototherapeutist, in his orthopædic clinic at Frankfurt makes use of both quartz and Sollux lamps on sunless days. According to his publications, the results appear to be rather good.

A third variety of artificial light is represented by the arc lamp, which, as is especially the case in the Finsen Institute at Copenhagen, is employed for irradiating surgical tuberculosis, the patient's whole body being subjected to such copious doses that they call forth erythema. In more or less robust individuals one can start with sittings of $\frac{3}{4}$ hour duration, adding $\frac{1}{4}$ hour every day until the maximum of $2\frac{1}{2}$ hours is reached *per diem*. This results in strong pigmentation and marked hyperæmia of the skin, the lasting congestion of the skin being the object aimed at in every case. The records published by the Finsen Institute are very striking and, as such, worthy of study. The costs of installation are, however, so considerable that this method cannot be widely adopted.

The fourth and last principle of phototherapy is the one materialized by Kisch in the shape of his oxygen-acetylene lamp, which is used in Bier's clinics at Hohenlychen. In the opinion of these two men, the curative effect of the sun rests exclusively on its ability to produce hyperæmia, which belief, however, is not at all correct. By means of the oxygen-acetylene lamp as constructed by Zeiss and meant to be used for local applications, it is possible to create on the surface of the affected joint a temperature of 42 to 46° C. In order to attain the same hyperæmia all over the body, these men employ another apparatus, namely, an electrical projector.

All the above-mentioned authorities make free use of sunlight, with the exception of the Finsen Institute, which works solely with arc lamp light.

In the interest of the large number of surgically tuberculous individuals who cannot be brought under the so favourable Alpine conditions, further perfection of the artificial sources of light is most urgently needed, for the latter appear still to be in a rather primitive state of development.

(*b*) *X*-Rays.

It is quite out of the question even to attempt here a brief description of the present-day position of Roentgenotherapy in surgical tuberculosis. We are obliged to confine ourselves merely to a few facts which resulted from our study of radiotherapy extending over a number of years.

X-rays and Solar Rays.—Are these two kinds of treatment compatible with each other? Is a skin pigmented by sunlight more susceptible to the action of *X*-rays than a normal skin is? Fründ in the "Therapy of the University Clinics of Bonn" (1920) demands that the affected part of the body should be protected against solar rays, because they render the skin over-sensitive to Roentgen rays, should the two kinds of rays be administered jointly. When, eleven years ago, we had first begun to operate with *X*-rays this point was naturally of the greatest importance to us. It is, indeed, quite likely that a slight degree of solar erythema renders the skin more susceptible to the other rays. However, we have no records of such cases, because we only handle cases which have already been insolated sufficiently to have developed more or less pronounced pigmentation. And as regards the properly pigmented skin, all we can say, on the strength of several thousands of sittings, is that such an increased sensitiveness to the *X*-rays does not exist, which was confirmed by cases receiving maximum doses (*Korrespondenz. für Schweizer. Ärzte*, 1917, No. 11). So that as soon as enough pigmentation is present no objections to a simultaneous application of sunlight and *X*-rays need be entertained.

Now there is another question requiring an answer, namely, whether the focal reactions as set up by both these therapeutic factors are not cumulative in a manner contrary to our intentions? Focal reactions following solar irradiation differ

considerably as regards intensity, and depend on the anatomical and clinical conditions of the part thus treated. It stands to reason, therefore, that we should not superimpose an *X*-ray reaction on a focal reaction already called forth by sunlight, because such a cumulation might obviously do harm. As soon, however, as the morbid processes have passed into a more tranquil state, there is nothing to stand in the way of a regular application of *X*-rays in the case of sunning patients. The decision in each individual case should cause no difficulties to an observant physician.

Dosage.—Let us remember that within our range of radiotherapy we have no need to work with doses bordering on erythema. We do not share, therefore, Disson's views, who recently announced that he does not differentiate much between tuberculous adenitis and malignant new growths. Six and a half years ago I wrote, in the *Korrespondenzblatt für Schweizer. Ärzte* : " Radiotherapeutists treating surgical tuberculosis should abandon the idea that it is the largest possible doses that will do their patients most good. What is right in the case of malignant disease is certainly wrong for tuberculous cases." Generally speaking, it is less easy to lay down hard-and-fast rules concerning the treatment of the latter as compared with the former variety of troubles. " The size of the dose depends on the clinical nature of the malady which is to be irradiated." Whilst giving powerful doses to the old-standing, torpid types, we shall treat active cases with great consideration and individual care. One focal reaction must be allowed to subside before a new one is created, and only when the reactions have become less vigorous is the dose increased.

In much the same way Professor Klewitz has spoken (*Münch. Med. Wochenschr.*, 1920, No. 10) concerning radiotherapy as applied to medicine. " The principles which obtain in deep irradiations of gynæcological cases must not be applied to medical cases without a certain limitation. . . . The rigid system of dosage prevailing in gynæcology would hardly be practicable in our medical cases. One is positively compelled to individualise in the latter." In other words, this is precisely the opinion which we, in Leysin, have

always held in respect of surgical tuberculosis. Kohler (Lexer's clinic) warns of the dangers arising from overdoses (*Strahlentherapie*, Vol. XIII, p. 3, 1922). Based on very wide experience, he recommends doses of 1·20 to 1·30 HED.

Copious doses of *X*-rays are liable to produce miliary dissemination of tuberculosis, for powerful local reactions are not without danger.

We are in the habit of giving at the first sitting 4 to 5X with 3 or 4 mm. aluminium. If this dose is well borne by the patient and he shows no violent reaction, we go up by $\frac{1}{2}$X each time, without ever exceeding 8X as a single dose. Cases of tuberculous peritonitis receive our utmost care: we commence with 3X, and take but one field at one sitting.

Total Dose. Delayed Injuries.—It is important not only to avoid primary cutaneous as well as systemic injuries from overdosing at each separate treatment, but also not to overstep that total dose which is likely to cause delayed injuries. That limit is not and cannot be strictly defined, for it varies according to filtration, and especially so according to the part subjected to treatment. Most sensitive and most liable to injuries are the foot and knee regions, which fact is fairly plausible considering how impeded the circulation in these parts is. Iselin's tables, showing total doses which produced *X*-ray damage in various parts of the body when filters of 1 mm. were used, are no longer of any value now that more intensive filters are employed. Of course, also with thick filters delayed injuries are possible. But whilst in the case of malignant tumours we might tolerate this contingency, in the case of tuberculosis it is quite a different matter. And whoever has seen a burn develop seven years after the last application of *X*-rays to an elbow joint, will not so easily forget the risks of delayed injuries. We are obliged to dole out our *X*-ray doses and to be ready to break off the treatment at the right moment. Radiotherapy should be of a "slowing down" character, according to Iselin's expression. This is all the more necessary since marked after-effects can still be seen months later. It is quite clear that when encapsulation and fibrous changes have once set in, they will go on spontaneously under the stimulus of the all-round improved health.

General Contra-indications.—Highly active, feverish cases are to be ruled out unconditionally. Fresh infections are also barred. In a fresh, active case of cervical adenitis, for instance, we should pay great attention above all to the weak system, and postpone the local treatment. Such patients should spend a few weeks or even months in the country, in the mountains, or by the sea, in order, as it were, to mobilise their forces and to harden their constitutions by means of air baths and sun baths. It is vital to note that fresh tuberculous infection calls for general and not local treatment. When the morbid processes have entered on a quiescent period, then, and then only, the time is ripe for an advantageous application of the *X*-rays.

Limits to Radiotherapy.—It follows from the above that we are confined to a definite total dose which must never be overstepped without the peril of latent injuries. This, however, imposes a serious restriction on radiotherapy. Frequently it so happens that even very large doses, but such as we can still administer in good conscience, prove inadequate to bring about recovery. There is no doubt whatever that the *X*-rays are able to exercise an intensive, local action—at least in the lighter kind of articular and synovial disturbances.

Iselin's subsequent examination of his old cases showed 69% recoveries of wrist-joint disease, 72% of elbow-joint cases and 60% of ankle and tarsus trouble. These figures are all the more remarkable because they related only to out-patients. That this method, however, is not sufficient when given by itself, is shown again by Iselin's statistics. He finds by going over his old cases 25% deaths amongst his wrist cases, 20% deaths in elbow cases and 24% in ankle and tarsus cases. It is true, though, that amongst these fatal cases there was a conspicuous proportion of pulmonary complications of tuberculous nature. Thus out of twenty-one wrist cases with lung trouble at the end of 3 years one was cured and sixteen were dead. Consumption of the chest darkens the prognosis also in our practice in Leysin, but not nearly so much as it does according to Iselin's tables. I am quite conscious of the fact that it is not right to compare two lots of results, each of which was obtained under different conditions: out-patients

on the one side, institutional treatment amidst Alpine air and sunshine on the other.

Yet we cannot help drawing the logical conclusion that, in spite of the beneficent local influence possessed by the *X*-rays, this method alone is, in a goodly number of cases, insufficient, for the obvious reason that radiotherapy given alone is unable to act on the whole organism of tuberculous subjects in the sense in which sunlight and Alpine air are capable of doing.

To sum up briefly, it may be said that *X*-rays and sunlight can be combined one with the other under specified conditions. The radiotherapeutic dose to be given in surgical tuberculosis depends on the clinical character of the trouble. Latent *X*-ray burns and other injuries must be carefully guarded against. Roentgenotherapy is a remedy endowed with an almost exclusively local action, and as such it forms a useful adjuvant to heliotherapy. General treatment, however, has the decisive voice in the fight against tuberculosis and, therefore, must on no account be neglected.

XIV. CONCLUSION

Both orthopædics and conservative surgery find the best realization of their principles in heliotherapy as recommended by us in the preceding pages. By doing away with bloody interventions, it preserves articular function intact, at least as far as this is ever possible; it prevents irreparable mutilations; it does not only prolong the lives of cripples and physically defectives, but it also restores normal individuals back to ordinary modes of living and to their employment, so that they can once more take up their fight for their daily bread. Having discarded the use of closed plaster-of-Paris splints, this method keeps the muscles and ligaments intact and develops them and thus retains the harmony of corporeal lines.

But this is not all. It does more than cure tuberculosis, for it also guarantees the results. And as a true prophylactic against the diseases of children, which so often pave the way for subsequent tuberculous invasion, heliotherapy is one of our best weapons with which we can arm ourselves for this modern warfare.

However, in this important and so ambitiously far-flung prophylactic effort, all depends on the indispensable co-operation of medical men. For it is they that are faced with all those questions which a layman, however well-meaning he might be, is unable to answer for himself. The doctor's advisory word has a particularly decisive effect during the deliberations on the various problems concerning public and social life; but his word becomes well-nigh irresistible if on such occasions it expresses his innermost personal convictions. His place in municipal affairs becomes more and more important with every day; for nowadays he is no more content to follow his patients only; he is actively participating in the struggle against all the enemies threatening the integrity of public health, the worst of them being tuberculosis.

We should be very happy to know that a large number of medical men perusing these pages have become convinced of the value and importance of heliotherapy. When once the attention of our fellow citizens has been successfully awakened in this direction, then also the doctors will realise that herein they have at their disposal a remedy endowed with singularly mighty curative powers able to inspire the breath of a new life even into the weakest and frailest of bodies.

But whosoever assists in carrying on this work and spreads the knowledge thereof around him, will render yeoman services to his country, which will not fail to behold in him a wise physician and a true patriot indeed.

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